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ELECTRICITY AT THE WORLD'S FAIR.

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I.

A PERIOD of but seventeen years separates the first great American exhibition from the second, yet what a vast difference between the two in the display of electrical appliances! The Centennial was not indeed without its electrical wonders, but these were unobtrusive and formed but isolated examples in an industrial domain which yet remained to be cultivated. Electricity had not then been brought home to the attention and interest of the thousands by multiplied daily use. It made no appeal to the imagination, and the immediate future that was to open for it was hardly dreamed of even by those in the vanguard of electrical discovery. The telephone here made its *début;* the quadruplex telegraph, but recently put into commercial service, was here shown for the first time; and the dynamos and arc lamps of Wallace were on exhibition. The Gramme machine, which was shortly to play such an important part in the commercial development of the electric light, and to prove such a stimulus to the inventors of electric apparatus, was also to be seen here, but beyond these electricity was very little in evidence at the earlier exposition. At the Columbian it is omnipresent. It is called upon to do the lighting of the great buildings and grounds, to the exclusion of all other means of illumination; to drive the trains of the intramural railway which winds through the exposition inclosure; to propel the graceful launches which glide through its waterways; to furnish the power distributed throughout the various buildings, and to make itself known in innumerable decorative effects. Grown too large to have a place merely, along with other

industries, in a general building, it has a temple of its own, which is filled with the manifold applications of this strange and subtile agent to the arts and conveniences of life. And even this is inadequate to the demands it has made upon the space of the exposition, for what may rightly be considered two of the main exhibits—the great alternating lighting plant and the direct-current plant of the intramural railway—are without the inclosure of the Electricity Building, the one in Machinery Hall and the other in a structure by itself.

Complete and varied as the Columbian electricity exhibit is, it is not primarily an exhibition of novelties. It is rather a summing up of our progress to date—a slice taken from the far larger exhibit which everywhere surrounds us and is helping to do the daily work of the world in shop and factory and mine, on our streets and in our homes. Much of that to be seen is already familiar, but it is not on that account devoid of either interest or instruction. In the actual industrial world the processes and appliances of an art are scattered and not easily accessible, and it can only be studied piecemeal and with difficulty. A great exposition, on the other hand, gives an opportunity for studying an art in its entirety, and thus enables an observer to gain a clear conception both of the attained progress and the direction of future development. This opportunity is afforded by the Columbian in a marked degree. Illustrative examples are to be found in it of all the more notable steps of progress, and many of the exhibits are remarkably full and complete.

The visitor will find, for instance, an opportunity to study the telephone from its earlier form up to the present standard instruments, and to inspect and perhaps understand for the first time the central station system, by means of which he is daily put into communication with other subscribers. He will see in actual working what he will have but little opportunity to see elsewhere, and which, to judge by the crowds which throng about it, appeals strongly to the curiosity and interest of the average visitor—the delicate siphon recorder of Sir William Thomson, by which all the cable messages of the world are received. And he may perhaps wonder that any one should be able to interpret into intelligible signals the curious zigzag scrawl which the siphon leaves upon the moving band of paper. He will also see a set of quadruplex instruments and be able to understand by actual inspection much better than by mere description this most important of telegraphic appliances. He will also be able to see in the Western Union exhibit the original receiving instrument of Morse, made of a triangle of wood hinged at its apex to an artist's canvas frame, and carrying at the center of its lower side a pencil, with which a zigzag tracing can be made upon a moving band of paper

beneath, as the triangle is swung to and fro under the impulses of an electro-magnet. The visitor will also have an opportunity to examine the new telautograph of Prof. Elisha Gray, by means of which the written word, it is promised us, may be transmitted to a distance with the same facility that the spoken word now is by telephone. Turning from this lighter and more delicate form of apparatus, the visitor will find a very complete display of the class of applications that has brought electricity into such close contact with the daily life of the masses in recent years. From the great Westinghouse lighting installation and from the power plant of the intramural he will get some adequate idea of a modern central-station equipment, while from the illustration of long-distance power transmission he will be able to comprehend one of the directions in which electricity holds out the greatest promise for the future. In the exhibits of electric welding and forging he will learn of the help the electric current is giving to the metal worker, and in that of cooking and heating the attempts that are being made to displace with electrical appliances the kitchen range and the hot-air furnace.

The most prominent exhibit of electricity at the fair is undoubtedly the lighting of the Exposition itself. This is carried out along lines already well established, and is remarkable chiefly for the great scale upon which it is planned and executed. Nearly five thousand arc lamps and a hundred thousand incandescents have been called into requisition for the illumination of the grounds and buildings. The placing of these required, no doubt, a great deal of detail work and called for nice discrimination in adapting means to ends, but involved no electrical problems of especial novelty. The lighting of the big Manufactures Building, with its thirty acres of main floor space and ten acres of galleries, presented the most difficult problem to the Exposition authorities, but this has been successfully solved by the use of the arc lamp hung from immense coronas along the central line of the building, supplemented by individual lamps in the corridors, galleries, and separate rooms. The coronas are hung a hundred and forty feet from the floor and sixty feet from the crown of the great arched roof which spans the structure, and are of colossal size, the central one being seventy-five feet in diameter and the two which flank it on either side sixty feet. Something over four hundred lamps are disposed of in this way, while to these are added some twelve hundred more to complete the lighting of this great inclosure. The incandescent, so flexible in the hands of the decorator, has been used very effectively to outline the buildings and the waterways of the Exposition, in addition to their use in interior illumination.

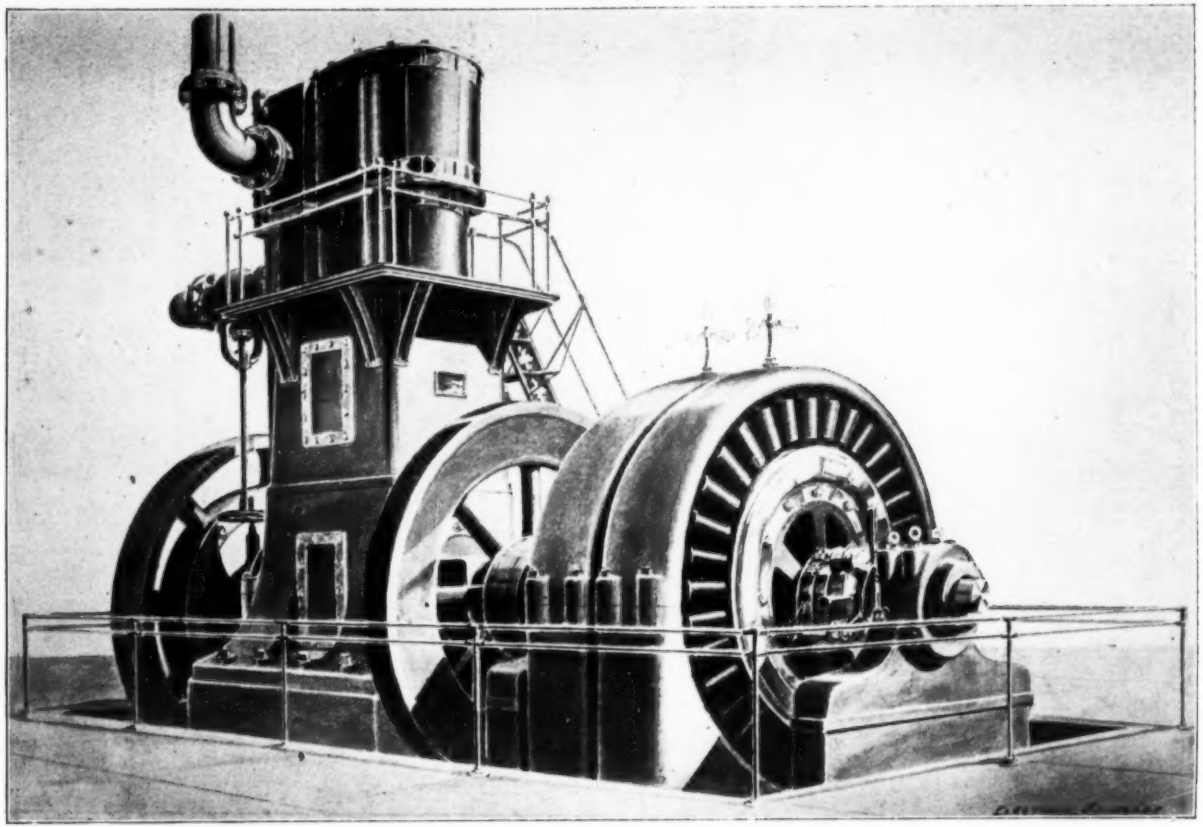

FIG. 1.—WESTINGHOUSE TEN-THOUSAND LIGHT ALTERNATOR. (From the Electrical Engineer.)

The power and machinery which give vitality to this vast array of lights are to be found in Machinery Hall, and constitute one of the chief electrical exhibits. The most striking feature of this exhibit is the great Westinghouse alternating plant, which supplies the current for the incandescent lamps. It consists of twelve enormous alternating-current generators, each having a capacity of ten thousand sixteen candle-power lamps and requiring a thousand horse power apiece to drive them. They are arranged in two groups, the first six of which are coupled direct to Westinghouse upright engines. Of the remaining six, four are driven separately by different makes of engines, and two are belt-driven in tandem fashion by an Allis-Corliss cross-compound engine nominally rated at two thousand horse power, but which may be worked up to three thousand horse power upon occasion. This engine is one of two of the same type and by the same maker, the other one being stationed in the power house of the intramural railway, and is regarded as a very fine example of modern steam engineering. The alternating generators themselves are of a type only recently devised, in which there is a double row of field poles, and a double set of armature coils, by means of which the machines can supply two separate circuits for the requirements of incandescent lighting, or furnish what is known as a two-phase current for use with alternating-current motors. The current as generated has a pressure of two thousand volts, which is reduced down, at the point of consumption by means of converters, to fifty or a hundred volts.

Besides the "alternators," as these machines are technically termed, there are a large number of direct-current machines in this building supplying the currents to the arc lamps, and the motors scattered through the various buildings. The plan adopted by the Exposition authorities has been to confine the engines and boilers to Machinery Hall, so that all the power required in the Exposition except that for the intramural railway, is generated here and transmitted by electricity through underground conduits to the place where it is to be used. The exhibition is therefore an illustration of the electric transmission of power upon a large scale, and should furnish a basis for the collection of instructive data.

The feature of the Exposition which will command the most interest of any of those in which light plays a prominent part will probably be the electric fountains. Fountains of this character have been features of a number of exhibitions since 1884, when the first one, designed by Sir Francis Bolton, was shown at the Healtheries in London, but those at Chicago are upon a much greater scale than any heretofore attempted. The principle of operation is that of throwing a powerful beam of light from be-

low upward along the axis of the water jet, the lamps being placed in a chamber under the fountain provided with a transparent roof. Color effects are produced by the interposition of glass screens in the path of the beam. In the present fountains, which rise from basins sixty feet in diameter, the underground chamber is built upon piling, a construction rendered necessary by the shifting sand foundation. The piling is of unequal length, the shorter piles supporting the floor structure, and the longer, which project through and are seen as pillars in the room, the roof. The water nozzles are grouped to form nineteen composite jets, and as many power-

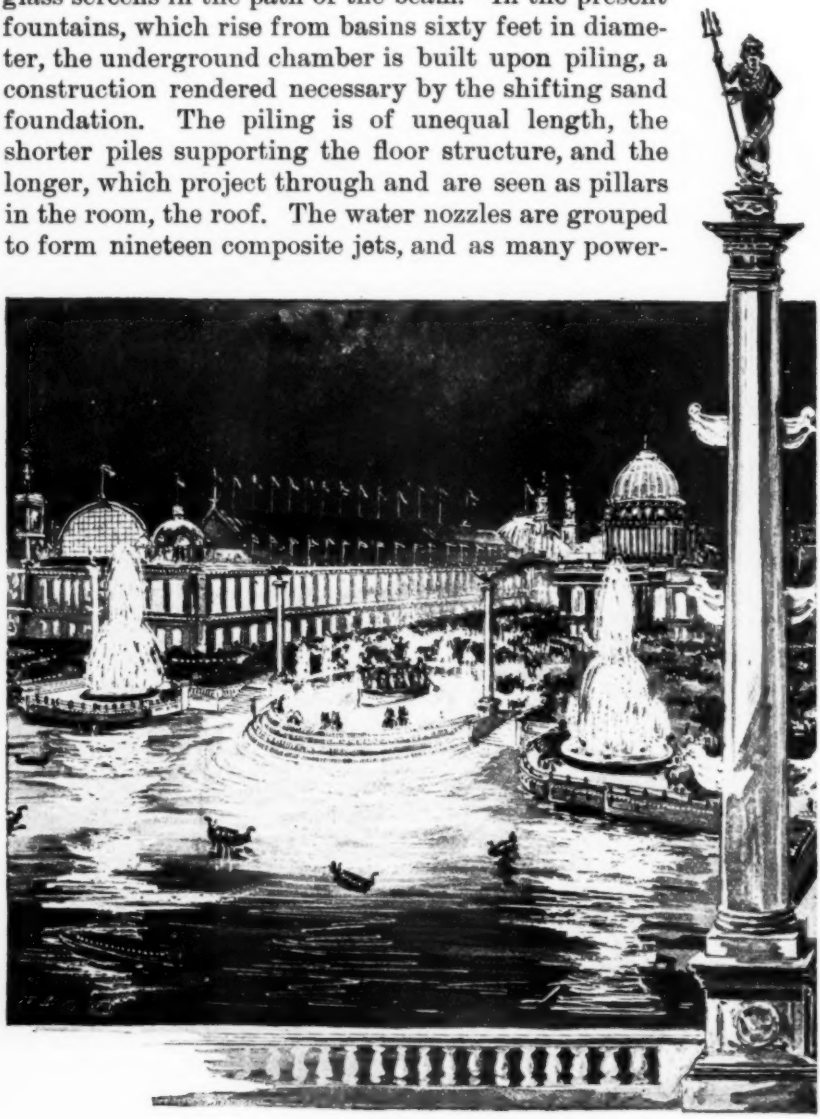

FIG. 2.—ELECTRIC FOUNTAINS.

ful reflectors are arranged to throw a beam of light along the axis of each group. It is estimated that the beam of these powerful lights has a luminous intensity of two hundred and fifty thousand candles. The size of the fountains may be appreciated by the fact that they require a twenty-four-inch supply main con-

veying water at a hundred pounds pressure, and have a consumption of nearly twenty-one million gallons per twenty-four hours. The central jet or grand geyser formed by a two-inch stream rises to a height of a hundred and fifty feet. The color screens are in the shape of fan blades arranged to rotate horizontally, and are grouped so as to be capable of producing an almost unlimited combination of color effects.

If any demonstration were needed of the capacity of the electric motor to take the place of steam on such roads as the elevated in New York and Chicago, or of the enormous superiority of electric traction in the matter of cleanliness, comfort, and freedom from noise, the intramural would furnish it to the satisfaction of any impartial observer. This road is a double-track elevated structure something over three miles in length, which forms the highway of communication between the different buildings. It is purposely laid out with many an unnecessary curve, to accentuate the conditions of actual travel, and demonstrate the ability of electric traction to do its work satisfactorily under extreme conditions. The trains are made up of a motor car and three trailers, all four cars being arranged to seat passengers, the space occupied by the motorman at the extreme front end of the motor car being no greater than that of the ordinary trolley car. The cars are open, with the seats extending clear across the car body, each pair facing upon the entrance aisles. These aisles are closed by sliding gates, which are connected so that all those on one side of the car may be opened or closed at the same time by the movement of a lever at the end of the car. This construction might be very readily adapted to a closed car, and would seem to be admirably suited to cars having the phenomenally heavy traffic of those on the elevated roads of New York. A very noticeable feature of the cars is the perfection of the lighting. Too often, when electricity has been called upon for the lighting of public conveyances, there has been but little improvement over former results, due both to the bad habit of placing the lights in the aisle spaces and stinting in the candle power. In the intramural cars particular attention has been paid to securing abundant light, the lamps being up to candle power and placed in the most effective position along the sides near the car roof.

The electrical equipment of the motor car consists of four motors having a combined capacity of over five hundred horse power. These are geared to the axles by a single reduction gear, and take their current from side rails through the medium of sliding shoes. The side rail was adopted in preference to a central one on account of the greater simplicity of the switching arrangements, the facility in getting at the contact shoes, and the very

limited space between the motor and road bed in which to make a satisfactory rail contact. The return path for the current is through the traffic rails and iron girders of the elevated structure, the rails being copper-banded at the joints and joined by bands of the same material to the girders. Feeder rails extend from the power house for three fifths of the length of the line and are cross connected to the supply rails at every rail joint. The train equipment of the road consists of eighteen trains, weighing when loaded about ninety-six tons each, the motor car accounting for thirty tons of this weight and the other cars for twenty-two tons each.

The central figure of the power-house equipment is the great two-thousand-horse-power generator from the shops of the General Electric Company, said to be the largest machine yet built. It occupies the middle space of the power house and is driven by an Allis-Corliss cross-compound engine, which is a duplicate of the one in the Westinghouse plant in Machinery Hall. It is a direct-current machine of what is known as the multipolar type. This is a type of machine which has been developed in recent years in response to the increasing demands of railway power and central lighting stations for larger units of power. In machines of the power desired slow speed becomes essential, and this requirement has resulted in radically transforming the design of the dynamos. The two-pole field magnet, common in all machines a few years back, has given place to a multipolar one, generally made in the form of a ring-shaped yoke with inwardly protruding pole pieces, though this construction has been reversed in some large generators constructed by Siemens, in which the field poles radiate from a central hub, and the armature, made in the form of a flattened ring or band, is placed on the outside, its outer surface constituting the commutator upon which the brushes bear. A fine example of this machine coupled direct to a thousand-horse-power triple-expansion upright engine is to be seen in Machinery Hall. In the intramural generator the field consists of two massive semicircles of cast steel, bolted together, the lower of which is provided with supporting feet. This yoke is fifteen feet in diameter and three broad and with its twelve poles weighs over forty tons. The armature is what is known as the ironclad type, and is ten feet and a half in diameter, and weighs complete about thirty-five tons. The ironclad type of armature now used upon all railway motors and large generators is a comparatively recent development, and possesses marked advantages both mechanically and electrically. Its characteristic feature is the imbedding of the coils in the laminated iron core, either by forming tubular passages through this core near the edge or making it with open slots narrowed at the mouth to securely hold the

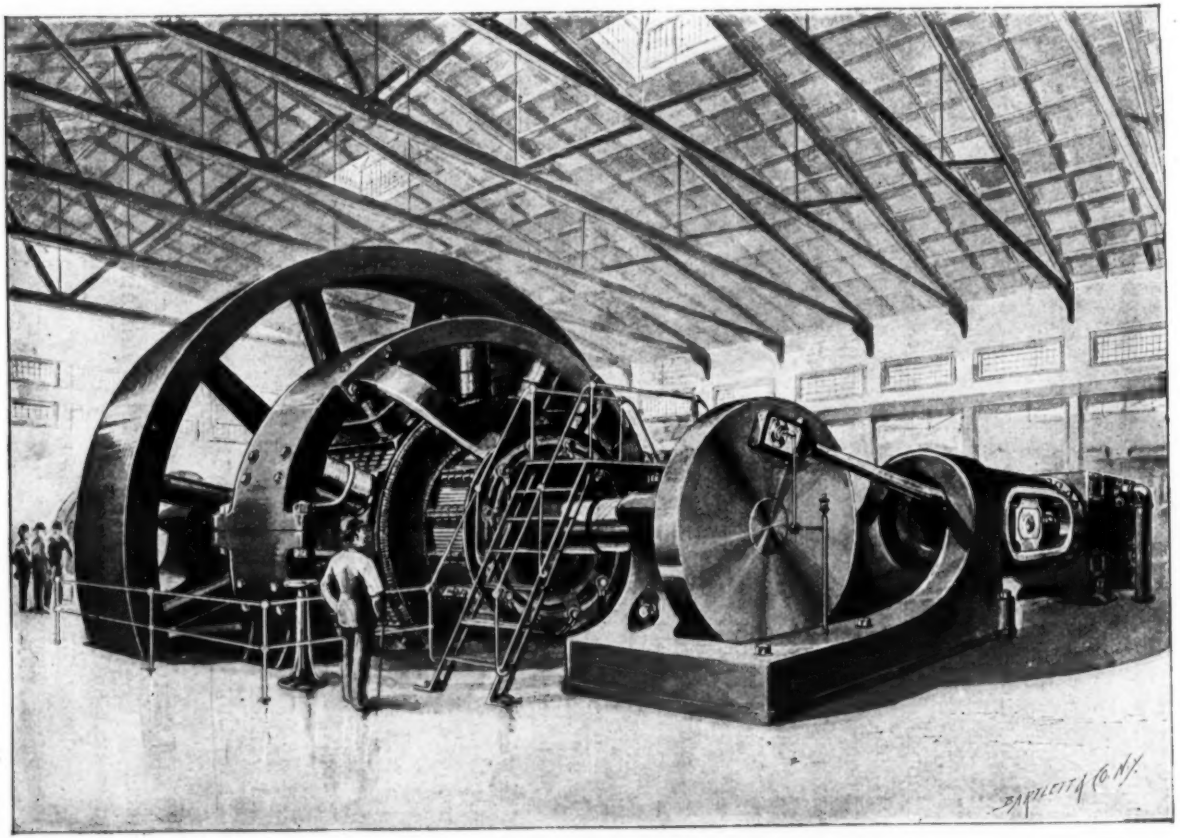

FIG. 3.—INTRAMURAL RAILWAY GENERATOR.

coils in place. It has the mechanical advantage of presenting a smooth exterior surface which can be turned true, and of holding the winding in such a way that it can not become displaced, as is possible with coils wound over the core and bound in place by a wrapping of wire. Electrically it has the advantage of materially diminishing the air gap—the space between the face of the armature and the field poles—and hence allowing the coils to move in an intenser magnetic field. The armature core is carried by a cast-iron spider weighing over fifteen tons which is keyed directly to the shaft of the driving engine. The brush holders, of which there are twelve sets, corresponding to the number of field poles, are mounted upon a yoke supported at one side of the field magnet frame. They are moved into position by means of a shifting gear operated by a hand wheel and are readily accessible from a stairway passing over the shaft. The machine is designed to run at seventy-five revolutions a minute and furnish a current under a pressure of six hundred volts. It has an electrical capacity of fifteen hundred kilowatts, and is claimed to have an efficiency of ninety-six per cent. This ponderous machine was found to be much too large and heavy to be shipped in its complete form, and was accordingly forwarded from the factory in parts and assembled upon its present foundation.

An appreciation of its size and capacity may be gained by remembering what the standards of size were only ten years ago when the Edison "Jumbo" was put to work in the first New York Central station. This machine, which created a veritable sensation at the Paris Exposition of 1881 on account of its immense size, required only a hundred and twenty-five horse power to drive it when working at its normal load. It had a capacity of less than one hundred kilowatts, which is but a fifteenth of that of the present "Jumbo," and weighed very much more in proportion to its output. It is to be seen in the exhibit of the General Electric Company, where it is rightly given a place of honor as the precursor of the race of modern direct-connected dynamos.

While a motor car will answer admirably for the lighter forms of electric traction, the invasion of the domain of the steam railroad, which electricians are already contemplating, will necessitate the design and construction of special electric locomotives. These have already been used quite largely in mine work, and a number of electrical constructors have designed and built such machines of moderate power, but the first one of any considerable size and designed for high speed is one built at the Lynn shops of the General Electric Company and shown in the Transportation Building at the Fair. It is a thirty-ton locomotive intended for a normal speed of thirty miles per hour, and is of sufficient

power for light passenger and freight traffic. It is mounted on four forty-four-inch wheels and is propelled by two gearless motors suspended in such a way as to leave the wheels free to adjust themselves to the irregularities of the roadbed. This method of suspension consists in mounting the motors upon spiral springs resting on the side frames of the locomotive truck, and the armatures upon hollow shafts through which the axles of the wheels pass, the connection between the two being made by uni-

FIG. 4.—GENERAL ELECTRIC THIRTY-TON ELECTRIC LOCOMOTIVE.

versal couplings. The commodious cab is constructed of sheet iron, finished in the interior in hard woods, and is given a curved shape to diminish as far as possible the air resistance. The braking power is furnished by compressed air supplied by a special electrical air compressor, and the whistle is operated by the same means. The use of the electric locomotive is not yet practicable on long lines on account of the great cost of long feeders, but this bar to its employment is certain to be overcome in time. Wher-

ever traffic is dense and the distance to be traversed not too great, the conditions are already present for the advent of this form of locomotive; and when we recall the rapidity with which city and suburban railways have spread, we can not doubt that once the problems of electric railway engineering are worked out, and the necessary preliminary work of demonstration gone through with, we will witness an equally rapid extension of electric traction to the steam highways of the world.

Ever since Faure started electricians on the quest of an economical storage battery, the peculiar fitness of such batteries as a source of power for pleasure boats has been recognized, and they have frequently been used for such purpose. The slow develop-

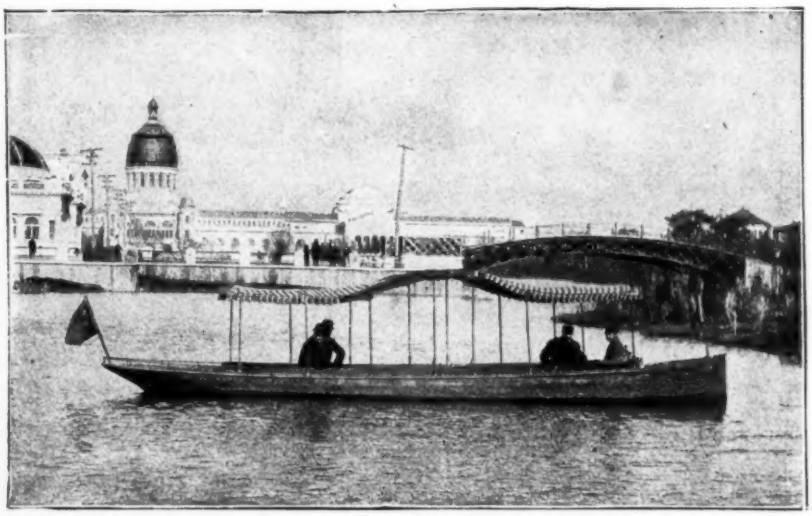

Fig. 5.—Electric Launch.

ment of this type of battery into an efficient instrument, the absence of any means of getting the batteries recharged, and the much greater cost of this method of propulsion, have heretofore acted to effectually prevent its adoption by the owners of such craft. But after riding in the launches of the exhibition one can not help but wish for the early dawn of the day in which this ideal method of water propulsion becomes generally available. The exhibition launches are of a very graceful model, about thirty-six feet long and six feet breadth of beam. They are designed to carry thirty passengers, and have motors capable of exerting four horse power. The batteries are placed beneath the seats and flooring, and as the motor is also beneath the flooring the cockpit is clear of any obstruction. Each launch carries seventy-eight battery cells, which, by appropriate connections, may

be grouped in various combinations. For the regular operation of the boats the cells are grouped in three divisions containing twenty-six cells each, arranged in series.

The batteries are charged for a run of ten to twelve hours, and are then recharged at the power station of the fleet in from five to seven hours. The launches run over a course of about three miles, at a speed of six miles an hour, and make landings at the principal buildings, all of which front upon the waterways.

To the engineer and to those who desire to know the trend of electrical development, the most interesting exhibit at the Fair will doubtless be the apparatus designed to show the long-distance transmission of power. Almost at the beginning of the modern electrical era, dreams were indulged in of the command which electricity was to give us of the natural sources of power. Marcel Deprez, at the Paris Exposition of 1881, had in operation a system of power transmission, and similar attempts have been made at every important exposition since, the most elaborate having been that at the Frankfort Exposition of two years ago. Of the importance of the economic transmission of power over long distances there can not be two opinions. The modern world has come to rest down upon an abundant and cheap supply of power in such a measure that without it civilization itself would go by the board. Statisticians have frequently shown that the coal supply, while large and ample for present needs, is not only exhaustible, but is being encroached upon at such a rate as to make its conservation a matter of grave concern. Electric transmission of power, by opening up to civilization the enormous supply of power of the waterfalls and running streams of the earth, will be able to postpone indefinitely the evil day that would be ushered in by the failure or material decrease of our fuel supply. To be of avail, however, such transmission must be economical, not only in the percentage of utilizable power sent through the line, but in the investment which must be made to realize it. So long as we were dependent upon the direct current, but little progress could be expected in this important problem. It has only been, therefore, in the last few years that the art was ripe for the taking up of this subject in a serious spirit, and with any hope of a real solution. The direct-current dynamo, handicapped with the commutator, is necessarily limited to supplying currents of relatively low voltage; the economic transmission of power demands the use of currents of small volume and very high pressure. This means small line conductors, and hence a relatively small investment. It means also a small loss in heating the line, since the heating power of the current varies as the square of the volume transmitted.

It is only by the alternating system of distribution that we can realize this essential condition of economy. We have here no such limit to the electrical pressure in the generating apparatus as in the direct-current system, and through the medium of the converter it becomes possible to vary the two elements of electrical energy—current volume and pressure—to suit the most widely differing applications. It is this latter feature of the system which gives it its great range and flexibility, and its consequent economic value. It enables us, for instance, to generate a current of a certain voltage at the machine, then to raise this to ten, twenty, or fifty times the original pressure for transmission through the line, and then at the far end to step down to as low a pressure as we may want—a pressure suitable for entering dwellings, offices, and shops, and safe in the hands of the consumer. These successive transformations and retransformations, it should be noted, are effected in the simplest kind of a way. They involve no machinery with moving parts, but simply coils of wire placed in such relation to each other that the currents passing in one induce similar currents in the other. The practical value of this system arose with the discovery that the induction coil, like the dynamo, is reversible. This coil had long been used to transform a current of considerable volume and low pressure into one of very great pressure and small volume. The construction which enabled this to be done consisted in making the primary coil with a few turns of stout wire; and the secondary—that on which the induced current was produced—of a great many turns of fine wire. It was presently discovered, however, that this mode of operation might be reversed, and that, by passing a high-tension current of small volume through many turns of wire, a current of large volume and low pressure could be induced in a secondary circuit of few turns, and that the pressure and volume of the induced current in relation to that of the primary one depended only on the relative number of wire turns in the two circuits. If, for instance, the primary and secondary coils contained the same number of turns, the pressure and volume of the induced current would be precisely the same as the primary one. If, on the other hand, the induced circuit contained ten times the number of coils of the primary, the current in it would have a tenth of the volume and ten times the pressure of the primary one, while if the relation of the two circuits were reversed the induced current would have its volume increased to ten times and its pressure reduced to one tenth of that flowing in the primary.

In the field of lighting this method of electric distribution has taken a leading place, and it is no longer questioned that it is destined to displace entirely all methods of direct-current supply. It has heretofore found but little application to power transmis-

sion, because it has lacked the prime requisite for such a use—a satisfactory motor. This missing link in the chain of appliances necessary to render the system complete has in recent years been supplied by the discoveries and inventions of Mr. Nikola Tesla, whose remarkable experiments with alternating currents of great tension and enormous frequencies have excited such widespread interest among scientific men. To understand the solution given to the alternating-current motor problem by Mr. Tesla it will be necessary to consider briefly the principle of the electric motor and the cause of the rotation of an armature in a magnetic field. If we take a loop of wire forming a closed circuit and place it between the poles of a magnet it will tend, when a current is flowing through it, to set itself so as to inclose the greatest number of lines of force—that is, in a plane at right angles to the line joining the magnetic poles. If the mechanical inertia of the moving loop carry it slightly past its position of equilibrium, and at the same moment the current through the loop be reversed, it will be pulled around by the attraction of the magnetic poles to a new position of equilibrium; and if at each of these positions there takes place a reversal of the current, continuous rotation of the loop will be produced. Where there are many loops, as in actual machines, the pull upon the moving system of coils tending to rotate it will be continuous and equal at all points of the rotation, as, while some coils are approaching and passing through the position of equilibrium, others are in position to have exerted upon them the maximum strain. The pull of the field magnets upon the moving conductors is greatly increased if these be wound over an iron center, as in this case each loop tends to set up magnetic poles in this core in a position at right angles to its plane. Two magnetic poles attract each other when of different polarity and repel each other when of the same polarity. The poles of the iron core are consequently repelled and attracted by the field poles with each change of the direction of the current, and this occurs in exact synchronism with the changing forces acting upon the wire circuits. It must, of course, be understood that with a continuous current the direction of the current in space is always the same. The alternating current impulses set up in the armature coils of the direct-current dynamo are through the device of the commutator made to follow each other in the same direction through the line. Arriving at the motor, these impulses pursue a continuous course through the armature always in the same direction, the positive current always flowing in by one brush and the negative out by the other. The armature coils, however, by reason of their rotation, present their two ends in succession to the positive and negative brushes, and hence are alternately traversed by the current in reverse directions. If now the commutator be suppressed

on both generator and motor, it is evident that the armature coils of the motor will be traversed by successive positive and negative electrical impulses at just the right time, if the armature rotates in unison with that of the generator, as both armatures then pass through like portions of their magnetic fields during the same current phase. If these alternating current impulses are not, however, properly timed, they will interfere with each other and the motor armature will not rotate. It is possible, then, to utilize the alternating-current dynamo as a motor, but only on the condition that it runs synchronously with the generator. Evidently it must first be brought up to the speed of the generator before the conditions are realized that will keep it in motion. As a practical motor it has therefore the fatal defect that it will not start of itself, and it has the further one that it is readily thrown out of synchronism by a slight excess of load, and is then speedily brought to a standstill.

Clearly an apparatus so sensitive as this could not be relied upon for commercial work nor expected to stand as a solution of

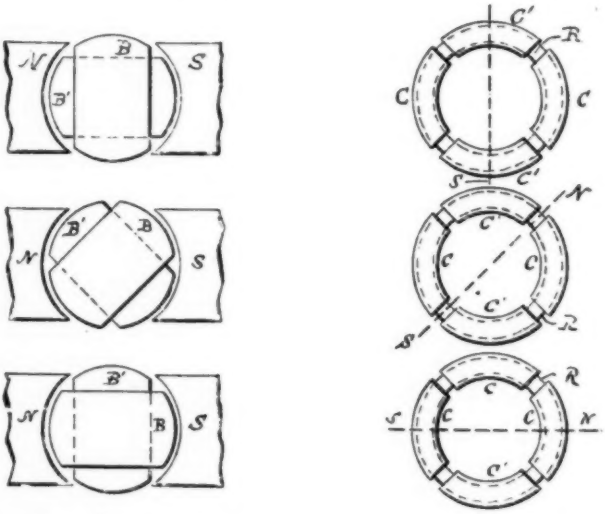

FIG. 6.—DIAGRAM ILLUSTRATING PRINCIPLE OF TESLA MOTOR.

the alternating-current motor problem. When Mr. Tesla took up the question he sought for a new principle of action and found it in what has since come to be known as the multiphase current. He conceived that by providing the armature of his generator and the field of his motor with two more sets of coils, connected so as to form distinct circuits, he would be able to produce a progressive shifting of the magnetic poles of the motor field, and thus drag around an armature capable of magnetic induction and placed within the sphere of influence of his rotating field. This

method of operation will be clearly understood from the diagrammatic sketch A (Fig. 6) and the illustration (Fig. 7) showing a diagram of the connections of the motor and generator circuits. Considering the latter first, M is the motor and G the generator. The armature A of the generator is wound with two sets of coils, B and B′, brought out through the shaft and connected with the contact rings *b b* and *b′ b′*. The field magnet of the motor consists of the iron ring R, also wound with two sets of coils, C C

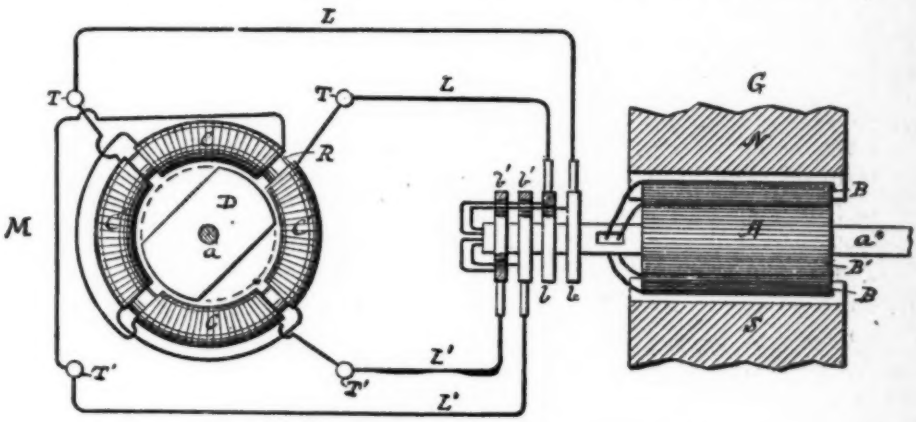

FIG. 7.—DIAGRAM OF TESLA MOTOR CONNECTIONS.

and C′ C′, the diametrically opposite coils being connected together in series. The generator coils B and the motor coils C′ C′ it will be seen are included in one circuit L, and the remaining generator coils B′ and the motor coils C C in another circuit L′. The armature of the motor consists simply of a disk of iron cut away at the sides, which becomes a magnet by induction when the motor field is energized. Turning to Fig. 6, B and B′ represent the coils of the generator armature and C and C′ those of the motor field as in Fig. 7. When the generator coils are in the position shown in the first diagram the coil B is generating no current and B′ is generating its maximum amount. The coils C of the motor field, which are included in the circuit of B′, are therefore traversed by their greatest current and produce magnetic poles in the iron ring R at N and S. As the generator armature revolves, B is brought to a position in which it is generating current, and when this movement amounts to one eighth of a revolution the circle will be in the position shown in the second diagram of the figure. Each of the pair of coils C and C′ will now tend to set up poles in the ring R of the motor ninety degrees from each other, and as their action is equal and opposite, the position of the poles will be determined by the resultant of the magnetic forces acting on the ring, and the poles will therefore be shifted around

the ring an eighth of a revolution. They will be shifted another eighth when the generator armature reaches the position shown in the last diagram, and will be successively displaced around the ring R as this armature revolves until a complete revolution has been made, when the parts are in their original position and ready to repeat the same cycle of operations.

The principle of the rotation of the magnetic poles has been applied by Mr. Tesla to a great variety of constructions. He has designed machines in which the field magnetism remains fixed and that of the armature is shifted, and others again in which there is a progressive shifting of the magnetic poles of both the field and armature in opposite directions. He has also found that the motor armature may consist of sets of closed coils, currents being developed in them by induction, and by making the induced portion of the generator stationary and the field revolving he has been able to produce apparatus free from all movable electrical contacts. In operating motors of this character Mr. Tesla usually employed a generator with multiple armature circuits as described above; but in the course of his experiments he discovered that the ordinary continuous or direct current machine could by slight alterations be made to furnish an alternating multiphase current as well as and in addition to the direct current. To accomplish this he found it was only necessary to add to the machine a pair of collector rings for each circuit of the multiphase current, and connect them with the proper armature coils. If, for instance, he desired to produce a two-phase current requiring two circuits from his generator to his motor, one circuit would include a set of coils in the armature of the generator that were passing through the position in which the maximum current was being produced, and the other a set of coils in which at the same time the minimum current was being generated. The phases of the current would then follow each other in the same order as in the previous machines with distinct circuits on the armature. With this form of machine a multiple-phase alternating current, it will be seen, can be taken off from the collector rings, while a direct current can be taken from the commutator, and a part or the whole of this direct current be sent through the field coils to energize them and then put to any use for which such currents are suitable.

This machine was later developed into what has come to be known as a rotary transformer. Instead of being driven by power it is driven by one of the forms of current which it is capable of furnishing, the other current being taken off and utilized. For example, if a multiple-phase current is passed into the machine by the collector rings it will be driven as a motor and generate direct or continuous currents. If, on the

other hand, it be supplied with direct currents, it will also run as a motor, and deliver multiphase alternating currents. This apparatus promises to hold an important place, if not an indispensable one, in any complete system of electric distribution. For many purposes, such as electroplating and electrotyping and all forms of electro-decomposition, the continuous current is essential, and for other uses, in the present state of the art, it can not well be dispensed with. One of these uses is the operation of electric railways. The alternating-current motor, though answering many of the requirements of a commercial motor, has one disadvantage in comparison with the motor driven by direct or continuous currents. It has a less powerful starting torque—that is, the pull upon the armature tending to rotate it is much less at the start than in the direct-current machine. In railway work a powerful starting torque is of the greatest importance, as a motor is frequently called upon to exert four or five times the power in starting that is needed to keep the cars in motion. Whether the direct-current motor will continue to be essential for railway work or not, it is evident that a device which enables either direct or alternating currents to be supplied to the consumer at will must add much to the flexibility and completeness of any system of distribution. With the apparatus as at present worked out it is possible to place a generating dynamo at the source of power, say a waterfall twenty miles away, produce with this multiphase alternating currents, raise the potential of these to any desired amount by means of a step-up converter, pass them through the line, and then at the distribution end reduce them through the medium of a step-down converter to any suitable pressure. These reduced currents may then be used direct for operating alternating-current motors, for running incandescent or arc lamps, and, through the medium of the rotary transformer, direct currents may be obtained for operating street railways and other continuous-current motors, both classes of lights, and all kinds of chemical decomposition apparatus. It might be supposed that the multiphase system of alternating currents was a departure away from the direction of line economy, so necessary a consideration in long-distance transmission, since this system requires two or more circuits. This, however, is not the case. It was early discovered by Mr. Tesla that the multiple circuits could have a common return wire, and it appears that the amount of copper in the combined circuits is actually less than in the single circuit required for the ordinary single-phase current.

The value of the departure in alternating apparatus made by Mr. Tesla has been very generally appreciated in the electrical world, and electric companies, both in this country and abroad,

have set themselves the task of working out complete systems of apparatus along the lines laid down by him. The Westinghouse Company, which early secured control in this country of Mr. Tesla's inventions, has developed a system using a two-phase current, while the other considerable American company, the "General Electric," has worked out a system employing a three-phase current, which form of current has also been adopted by the Allgemeine Elektricitäts Gesellschaft of Berlin. All these companies make an exhibit of this class of apparatus at the exposition, arranged to show the system in operation. The exhibits of the two chief American companies are substantially the same, differing mainly in the character of current used. Each shows the generation of multiphase currents, their transmission to the point of distribution, and their utilization in alternating and direct current apparatus.

How completely the problem of the distribution of electrical power over long distances has been solved by this system, and to what extent we may expect to see it pass into commercial use, experience alone can determine. Disregarding its future utility, when we will perforce be driven to the utilization of natural powers, and looking only to the immediate present, it is not difficult to see that its adoption will be primarily determined by the cost of operating local steam plants. Where fuel is abundant, and hence cheap, there will be little inducement to resort to sources of power at a distance, but in all situations in which this condition does not obtain, and water power is to be had within a reasonable distance, electric power transmission will find a field, and one which will constantly widen with experience. While the utilization of water powers is the most obvious use for electric power transmissions, and certainly its most immediate one, it is quite possible that it will not prove to be the only one. As is well known, a large part of the cost of coal to the consumer is the expense of hauling it from the mines. It has been often pointed out that if the coal could be burned at the pit's mouth and its energy transmitted to the place of use there might result a great saving, but any economical method of doing this has heretofore been wanting. The suggestion has many times been made to convert the coal into gas and distribute this, but the cost of piping has heretofore rendered this method of eliminating the cost of railroad carriage impracticable. It would seem, however, to be quite within the range of practical possibilities to find in electric transmission an efficient and economic method.

[*To be concluded.*]

THE DUTY OF THE STATE TO THE INSANE.

By Dr. ANDREW MACFARLANE.

LUNACY legislation in the State of New York has been marked by two recent acts which are among the noblest monuments of the State's generosity, as well as witnesses of a scientific appreciation of the needs of the unfortunate class who are affected by them.

These acts are:

1. The change in the titles of these State institutions from lunatic asylums to that of State hospitals.

2. The State care of the chronic insane.

The first is the natural outcome of modern ideas on the subject of insanity, which is now regarded not as a manifestation of the evil one, but as a disease of the brain, affecting it in the same way as pleurisy affects the pleura or peritonitis the peritoneum, and that those suffering from mental disease should be treated not as criminals or dangerous madmen but as very sick people.

The second is a grand philanthropic work, proving that the State cares for even the most unfortunate of her children, and seeks to soften as much as possible their sad lot.

The time is fortunately past when these measures required advocates, and to-day it is necessary to keep in view only what are the best means for carrying to a successful issue both of these measures, and to consider if in any way the one tends to render the other less successful.

The fact that it is thought the saddest affliction which can befall mankind, that it affects all grades of society, that three out of every thousand are its victims, makes the consideration of the care of the insane, from the purely scientific, the philanthropic, or the economic standpoint, a subject worthy of the most serious thought and of the deepest interest to all. To-day (May, 1893) there are in the State of New York 17,814 insane patients under legal certificates of commitment in thirty-two public or private asylums, whose buildings and equipments have cost $17,500,000, where 2,900 people are employed, and which are maintained at an annual cost of $3,500,000.

This huge creation is the work of less than fifty years, for in 1843 the Utica Asylum, the first State institution for the insane, was opened for the reception of patients. Bloomingdale Asylum, a private institution, had, however, been in successful operation for many years, and was then in receipt of an annual grant from the State, and the asylum on Blackwell's Island began in 1842 to care for the insane in New York city.

The erection of the Utica Asylum marked the first decided step

in the humanitarian care of the insane by the State and the recognition of the obligation of the State to these unfortunates. It was designed that the Utica Asylum should receive all the recent cases of insanity. Those who, after a period of treatment, were deemed incurable were to be returned to the county houses, thus making room for all the recent cases. This condition lasted until 1865, when public opinion, shocked and horrified by the treatment in almshouses of the chronic insane, who then numbered 1,300, demanded that these, the most wretched of all God's creatures, should receive at least kindly care. The Willard Asylum was therefore established in 1865 for the care of the chronic insane, who were to be there maintained at the lowest rate conformable with a plain, simple diet and humane care. All the counties were required to send their chronic insane to the Willard Asylum except those which furnished suitable maintenance for them. Twenty counties, largely because of inadequacy of accommodations in State institutions, were accordingly temporarily exempted from the operation of this act. The State, however, continued to build State asylums: at Poughkeepsie in 1870; at Middletown in 1874; at Buffalo in 1880; at Binghamton, the State Inebriate Asylum, first used as a State asylum, in 1879; and the St. Lawrence Asylum in 1890.

The State asylum for insane criminals, formerly at Auburn, now at Matteawan, has not been considered in the following statistics, as the conditions there, on account of the character of the patients, are peculiar to itself and different from the other State hospitals.

The same general principle was carried into effect in their design—that is, the Utica, Poughkeepsie, Buffalo, and Middletown asylums were for the recent cases, while the chronic incurable cases were sent to the Willard and Binghamton asylums. The reason for this was the recognition of the difference in the requirements of these two classes of patients—the acute and the chronic insane. The acute insane are often dangerously sick, and should receive all the strictly medical care and attention which the character of their mental disease demands, the custodial supervision being here entirely secondary and kept as much as possible in the background. The chronic insane are incapable of living at home, and almost no hope of their recovery is entertained. These require custodial care, with incidental medical supervision. Their care is purely a question of sociology, of interest to the philanthropist rather than the physician. The supervising spirit, however, must always be medical, as only a scientifically trained mind can properly appreciate the influence of surroundings on their welfare, and can wisely and humanely classify them as their mental condition gradually changes.

This difference, too, is most strikingly shown by the fact that the average weekly cost per patient in the acute asylums was $5.29, while in the Willard and Binghamton asylums for the chronic insane it was less than half that amount, or about $2.60. The ratio of physicians to patients in the acute asylums was 1 to 110, while in the chronic asylums it was 1 to 272. The recovery rate on average daily population was twenty per cent in the acute asylums, while in the chronic it was two per cent. The average recovery rate on admissions was about thirty-three per cent in acute asylums and about five per cent in chronic asylums.*

In spite of the fact that the State had built many new asylums, the number of insane patients in the State increased more rapidly than the accommodations provided for them. The counties also found it more economical to abuse, under the guise of care, many of their own chronic insane. The result, therefore, was that the number of these unfortunates in county houses had in 1889 increased to 2,200. Their condition was most pitiable, and the recital of what they were subjected to carries one back to the barbarities practiced in the middle ages and by savage tribes. The Charities Aid Association, President Craig of the State Board of Charities, and Dr. Stephen Smith, then State Commissioner in Lunacy, kept for three years nobly at the work of making public this disgrace and blot on our civilization. Finally, in 1890, the present State care act, the consummation of their endeavors and those of the present commission in lunacy created in 1889, became a law. This State care act calls for the removal of all the insane patients from county houses to State hospitals and their care therein. New York and Kings (Brooklyn) Counties are exempted from this act, as they are considered to furnish suitable accommodations distinct from their poorhouses for their insane. The State has been divided into districts, and each hospital has its own district, from which it draws all the patients, both acute and chronic, thus making all the State hospitals of the same character—that is, mixed hospitals for the care of both the acute and chronic insane, instead of hospitals for the acute cases and asylums for the chronic incurable cases.

In order to furnish accommodations for this large increase to the State hospital population, it has been designed and is now being carried out to erect cheap buildings as annexes to the present State hospitals on the hospital grounds at a cost of $550 per patient. These buildings are intended for the more easily managed chronic cases, and will enable the State to care for the 2,200 insane patients who were inmates of county houses before this

* Many of the recoveries in chronic asylums were of acute cases of insanity in persons living in the immediate vicinity of the asylum.

act went into effect. Each hospital is allowed $4.25 per week for the first three years of residence of each patient, and $2.50 per week for any period beyond three years. It is also intended that one assistant physician should be assigned to every two hundred patients.

The thought now arises, What kind of medical care do insane patients require, and what has and will be the effect of this huge influx of chronic incurable insane upon the true object of a State hospital, the cure of the insane?

The demand for and the recognition of the need of a more distinctively medical care for the insane is shown by the change in the titles of institutions for the insane from asylums, a place of refuge, to hospital, a place of cure; a movement which is so general as not to be due to any local cause or influence, and also in the recent pleas of some prominent alienists that the acute insane should receive the same kind of medical care as patients suffering from any other acute ailment. The latter go so far as to advise the establishment of a hospital for the acute insane on the same lines as those of any general hospital,* with its visiting staff and thorough attention to all physical disorders in addition to the mental disease.

To-day the solution of this question lies either in a general hospital for the acute insane or in the hospitalizing of the old asylum or part of it. A general hospital for the acute insane would not, I believe, be advisable, and could not be properly conducted except in the large centers of population where there are many specialists in insanity. The duration of the illness, the need at certain stages of the disease of diversion or occupation, because there comes a time when such influences are most powerful for good, the difficulty of determining at once whether the disease is curable or not, thus tending to overcrowd such an institution or necessitating frequent changes; all these would make impracticable such an institution. Then, too, the fact that in our present State hospitals most of the patients come from small cities or the country, where there are poor or no hospital facilities and certainly no specialists, would necessitate the erection of many special small hospitals in these places or the transference of these patients to large cities with all the attendant ill effects—noise, excitement, and close quarters.

But that acute cases of insanity, however, need some kind of hospital treatment is evident. No less an authority than Dr. J. Batty Tuke has thus written: "The subjects of most of the insani-

* By general hospital in this connection is meant a hospital constructed on the same lines as other hospitals for special diseases or the establishment of special wards in a large general hospital.

ties are very sick people indeed, for, in the first place, they are in danger of their lives; and, in a second, they are in imminent danger of lapsing into that living death, terminal dementia. Each case, under circumstances of curative rest and calm, requires special hospital treatment, conducted on identically the same principles as those that regulate practice in our general infirmaries, and conducted under similar conditions as regards rest, nursing, and therapeutic agents. The existing system of asylum structure, management, and treatment makes this almost unattainable. No class of cases requires the attention of trained nurses more than subjects of recent insanity."

Can the present State hospitals provide such accommodations and give such care as Dr. Tuke claims the acute insane for their proper treatment need? I believe they can, and also that the accommodation and care there provided could be made far better than any that might be furnished in an institution established exclusively on the lines of a general hospital.

Unfortunately, Dr. Tuke's charge that "the existing system of asylum structure, management, and treatment makes the medical care of the insane almost unattainable," is alas too true. The erection of palatial buildings, which would be grand and magnificent monuments to an architect's skill, a State's pride, or a physician's ambition, has too often predominated over modest, simple structures, which could be rendered homelike and natural to the inmates. The fact is that though millions of dollars have been appropriated for the care of the insane, and thousands of capable men have spent their lives in this line of work, very little has been discovered in America about the real nature of insanity, and to-day the whole subject is a *terra incognita* whose shores have scarcely been touched, and which furnishes a number of the most difficult but yet the most intensely interesting problems to be solved. This condition is the result not of a want of ability or investigating spirit among asylum physicians, but is the natural outcome of a system which so handicaps them with extraneous duties as to render long-continued original medical work almost impossible.

A physician has under his care on the average more than two hundred patients, both acute and chronic. The desire to get as many of these as possible engaged in suitable occupation, the wish to make the unhappy lot of the chronic insane a little brighter by entertainments of various kinds, the routine history-writing, the correspondence, the attention to the visits of the friends of this large number of patients—all of which, needful and necessary in their way, make so many demands on the physician's time that medical work becomes necessarily secondary and the administrative duties the more important work.

Though legislative enactment has made all asylums hospitals in name, it has not accomplished this in fact. To-day the tendency of the State care act, though noble and generous in its inception, has been to make the hospital treatment of the curable insane almost impossible, or at least most difficult. It has crowded all the State hospitals with a mass of patients for whom nothing medically can be done, thus essentially interfering with proper classification. It compels the placing of recent, curable, maniacal, and suicidal cases with old chronic patients who are violent, destructive, and filled with all kinds of delusions of persecution and various hallucinations. These tend not only to strengthen the newcomers in their own morbid ideas, but to implant many new ones. Their influence on the terrified, depressed, and deluded is especially pernicious. It is not necessary to paint a word-picture of the sad effect of such surroundings on these sufferers. Every asylum physician has been deeply touched by the descriptions by recovered patients of the shock upon them on admission of their surroundings; the shouts of their neighbors, the indescribable fear of other patients, the frightful thought, "This will be my fate," the baneful remarks of mischievous patients present in every institution who, with show of sympathy, say to the hypersensitive newcomer, "Such a one has been detained here these many years, and doubtless you will be."

These are not argument-made examples, but exist in every State hospital. They not only influence temporarily the imagination, but often do irremediable damage to the mind. The Pennsylvania State Lunacy Report, in considering this subject, says: "The acute are often heard to allude with horror to the condition of the chronic patients, dwelling most painfully upon the imminent probability of soon becoming hopelessly lost to home, friends, and society, and of passing the remainder of their lives in similar seclusion. Like begets like, and as the population of any hospital for the insane is chiefly chronic, there being relatively only a limited number of acute cases scattered through the various wards, this evil association must rob society of many a useful and productive citizen by placing him in daily contact with those who mar his chances for recovery." These are the mental and moral effects of such intercourse.

The chronic insane by the mere force of numbers also influence too much the character of the management of a State hospital and turn it from its true work, the cure of the insane. They constitute more than nine tenths of the entire number of patients in every mixed asylum, and receive more attention and care than the character of their condition demands, thus depriving the curable insane, who are less than one tenth the number, of much of what the hopefulness and acuteness of their sickness needs and requires.

In justice, it must be said that every asylum physician seeks to give the acute cases the larger part of his time, but the press of other matters, non-medical, so encroach upon his time that he usually finds that he has neglected, or at least has not done as much for them as he might have accomplished under *other circumstances.* What, then, are these *other circumstances,* and how can a State hospital take better care of acute cases than a general hospital?

Let us take, for example, a State hospital of one thousand patients. The staff would consist of a medical superintendent, five assistant physicians, and a woman physician. In a hospital of that capacity there would never be more than one hundred patients who would be considered curable, and the number would probably not exceed sixty. More than nine hundred patients would be hopelessly incurable, for the most part the wrecks of past disease, who practically need nothing but kindly custodial care with incidental medical treatment. Two, or at most three, physicians could easily do all that a humanitarian spirit might deem necessary for such a number of this class of patients. Three or four physicians would thus be left to devote themselves to the curable patients. Instead of constructing annexes for the harmless patients, let these be lodged and cared for in the huge barracks-like main buildings, the creation and legacy of a former generation. Then erect at suitable distances from the main building three or four houses for the treatment of the curable patients. These should be built simply and comfortably, so constructed as to do away with the huge institutional feeling and to give them a homelike appearance, and so furnished as to take away as much as possible all indications of confinement and restraint. They should contain no wards, but plainly furnished single rooms with sitting-rooms, thus permitting the utmost privacy, with the opportunity of intercourse when deemed beneficial.

Here the real medical work of the hospital should be done, and no labor should be spared which would in any way tend to the recovery of a patient or help to solve any of the unknown problems of insanity.

Electricity, massage, baths of all kinds, thorough examination of the blood and the various excretions, the use of the sphygmograph and ophthalmoscope, together with a very thorough physical examination would easily and most profitably keep employed the number of physicians assigned to the acute cases. For it is in this acute and presumably curable period that the case should have everything that medical skill and unremitting attention under the most favorable circumstances can confer. The disease must be arrested in this beginning stage if it be in our power to arrest it.

The nurses, too, should be especially selected for this service among the curable insane. Those who have, by work among the chronic insane, shown that they possess the aptitude and tact necessary to care intelligently for such patients could easily be selected for this special work. Then with these nurses could be placed several nurses who have had general hospital training and who would therefore be more apt to regard insane patients from the purely medical side. The number of nurses, too, should depend upon the need of each case; if necessary, a single nurse should be assigned to a patient, though this, probably, would rarely be required. The criterion, however, should be, What will be most helpful in a curative way to the patient? The nurses would thus feel the great importance of the work they were doing, because every case would be considered as a curable case, and there is no greater incentive to good work than the feeling that the work is of great value. By a slight increase in the wages in addition to the importance attached to the work, the very best nurses employed in the hospital could be secured for this work, and easily made most enthusiastic about it. The effect also upon the medical staff would be most beneficial. Any one who has seen the tendency to the undermining of the medical spirit in talented, brilliant, and ambitious physicians who have accepted State hospital positions, will appreciate the importance of anything that would increase the medical spirit in State hospitals.

In a discussion before the British Medico-Psychological Society on the subject How can the medical spirit best be kept up in asylums for the insane? the following means were most strongly dwelt upon:

1. Classification—that is, separation of the curable from the incurable asylum population.
2. Necessity for hospital treatment for the curable.
3. Necessity for training the attendants.
4. Necessity for more physicians to asylums, and a rearrangement of their duties.

Such purely medical treatment of the curable insane can be best carried out in annexes to the present State hospitals and under the same management. The State in each State hospital has a most valuable plant, with large, handsome grounds, conveniently situated to the section of country from which it receives its patients. They are in charge of well-equipped and competent medical officers who have given their lives to this work, and especially appreciate the needs of this class of patients. Then, too, there is the body of trained nurses from whom the special nurses could be selected. There are also in existence various industries and means of amusement, which, though hurtful in certain stages for some, might be and are used with great advantage in the con-

valescing period when the acute insane are not so susceptible to morbid influences. But most important, because of the difficulty of determining at once in some cases the curability of the disease, is the possibility of keeping under observation doubtful cases until the character of their disease can be determined and they can be correctly classified. Transferences from the chronic to the acute buildings could also easily be made if any supposed chronic case should manifest signs of mental improvement.

The State has always recognized the principle that curable patients required more and better care and attention than the chronic cases. This was formerly shown by the greater sums per patient given to the hospitals for the acute insane. The same fact underlies the present allowance of $4.25 per week for the first three years of hospital residence, the presumably curable period, and $2.50 per week for the remaining time, when the patient would be regarded as chronic. This is an exceedingly poor, though probably under the circumstances the best, way to meet this problem, the difference in the character of the care required by the curable and the chronic patients. Only sixty per cent of the admissions are curable cases; the others can be diagnosed as incurable at the first meeting, and require only the simple care which chronic patients should receive. As the hospitals are now constituted, the acute cases are placed among the chronic, and of necessity can receive little more than the average care of the hospital. We have here a double injustice: first, greater sums are given for some patients (those whose recovery is hopeless from admission) than the character of care for their disease demands; second, many (those who are curable at admission) do not receive the extra care which their illness demands, and to which the increased sum ($4.25) entitles them. It practically means, therefore, that the increased sums received from the recent cases go to elevate the general standard of care of all the patients rather than to be expended exclusively on the acute cases for whom this increased amount is given. Thus the chronic cases get more care than it was designed that they should have, or than they really need, and the acute patients are deprived of the better care and attention which it was intended they should receive.

"The duty of the State is such provision as to accomplish the largest result in the restoration to health of curable cases, the element of expense being here a subordinate one, and for the remainder such comfortable provision as shall insure safety to the community and humane care to the sufferer." *

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* Address of Dr. W. W. Godding, Superintendent of the Government Hospital for the Insane, Washington, D. C., read before the National Conference of Charities and Corrections, September 16, 1889.

The medical superintendent could determine on the admission of patients which were incurable and which gave hope of cure. The State should then appropriate such moderate sum per person for all incurable patients, whether of recent admission or of long-standing disease, as to enable these sufferers to receive kindly care and a few of the pleasures of life. For the curable cases in the hospital annexes no reasonable expense should be spared. This is true economy regarded either from the philanthropic, economic, or scientific point of view. The curable patients come entirely from the strong people who have earned their own livelihood, and have done their part in the world until, loaded down by ill-health, trouble, or care, they break down and go to a State hospital for treatment. The mental weaklings, the victims of the degeneracy of their ancestors, the last step before the extinction in them of the species—these, who have always been a burden on the community, are all to be found in the incurable class.

It has been estimated that the average duration of life of a chronic insane person is twelve years. This represents in money expended for care and in lost productiveness about five thousand dollars. The economic importance, therefore, of saving every patient possible from lapsing into chronic insanity becomes apparent. It is reasonable also to suppose that with such hospital care the duration of sickness in curable cases would be lessened, and that many would more quickly resume their former occupations.

The moral effect, too, upon the general public would be marvelous, and the strictly medical aspect of insanity would be appreciated by the lay mind. It is an accepted scientific fact that insanity, in curable cases, is curable directly in proportion to its early medical treatment away from home associations. The public, when the character of the hospital annex for recent cases and the importance of early treatment were understood, would not regard a State hospital as a place of living death, only to be resorted to when all other means fail, and often after all hope of recovery or possibility of accomplishing any curative measure is past.

The cost per patient in the hospital annex would not be more than is now expended in any good general hospital, and would not exceed nine or ten dollars per week for such patient. Such a method would not be any more expensive than the present system, and when the permanent effects are considered would give the best results and would also be a positive saving. The average weekly cost under the present conditions per patient is three dollars and a half, or $3,500 for a State hospital of one thousand patients. Under the separate plan of treatment, the curable patients, numbering not more that eighty, could be maintained at a weekly cost of ten dollars per patient, or $800; the nine hundred and

twenty chronic incurable patients could be humanely and kindly cared for at three dollars per week for each person, or $2,760, thus making the total cost of treatment, under probably the best conditions, $3,560.

This mode of treatment of the insane, far from being Utopian, is at present in successful operation in Strasburg and Heidelberg, and is about to be carried into effect in some of the Scotch asylums. The most eminent alienists in Great Britain and America have strongly advocated it.

Lord Shaftesbury, before a select committee of the House of Commons in 1887, thus explained the intention of the promoters of the early lunacy laws: "The asylum was to be divided into two; there was to be the principal asylum, which was for the acute cases; and there was to be a chronic asylum alongside of it, which was for old, chronic, incurable cases. All the recent cases were to be sent to the principal asylum, which was to have a full medical staff, and everything which could be necessary for treatment and cure."

Dr. J. Wigglesworth, superintendent of an English asylum, in the discussion on The Future Provision for the Chronic Insane before the British Medico-Psychological Society, said: "A more important question than the care of the chronic insane was whether they could not make a more determined effort to do more for the cure of the recent cases. To do this they must hospitalize asylums more. They must have small buildings properly officered and equipped, to which all recent cases should first be sent. The increased knowledge thus obtained would without doubt in time bring about an increase of the recovery rate."

Dr. H. Hayes Newington, in his presidential address delivered at the annual meeting of the Medico-Psychological Society of Great Britain in 1890, advocated the hospital annex for curable cases within easy distance of the main building. He stated that, in a hospital of one thousand patients, not more than sixty on an average would need such treatment.

Dr. D. Hack Tuke, in discussing the above address, said: "There should be means of treating acute cases in a separate hospital block, one in the construction of which no reasonable expense should be spared; or there should be a hospital at some distance from the asylum, on the lines laid down by Dr. Newington."

Dr. E. B. Whitcomb, in his presidential address before the British Medico-Psychological Society in 1891, stated: "The hospital treatment of the acute insane would insure the separation of acute from chronic insanity, sustain and encourage the more rational treatment of insanity as a symptom of physical derangement; but above these a well-constituted hospital would be the means of promoting to a greater extent and in a more elab-

orate manner than at present exists a scientific and wider knowledge of the disease. Such a hospital should be administered on the most liberal principles, not as you see at the present time in a competing spirit as to the smallest cost, but having a due regard to frugality in its truest and most economical aspect—the cure of the insane."

Mr. William P. Letchworth, formerly President of the New York State Board of Charities, in a scholarly and careful *résumé* in his admirable work, The Insane in Foreign Countries, advocates thorough remedial measures in small hospitals, no matter how expensive, for the acute insane, as not only more humane, but in the end more economical.

Dr. Chapin, Superintendent of the Pennsylvania Hospital for the Insane, in his presidential address before the superintendents of institutions for the insane, said: "Every hospital should have a special organization for the medical treatment of its recent curable cases. Is it the better way to continue our recent cases in the wards of large hospitals in constant contact with hundreds of chronics? To this serious and important interrogatory I must enter an emphatic negative answer, and believe it is not too soon to sound a note of warning. The needs of the recent and acute cases may be best met by the erection in connection with our State asylums of small and well-appointed hospital wards for the strictly medical treatment of such cases."

The late Dr. Bancroft, Superintendent of the New Hampshire State Asylum, thus wrote on this subject: "I have little doubt that moderate-sized hospitals constituted and operated either independently or as annexes would return increased ratios of recovery while adding vastly to the comfort and happiness of patients during hospital residence. Such adjustment would diminish routine, secure the largest degree of personal freedom and indulgence, and guarantee to each individual the best remedial influences as well as protection from such as are both distasteful and detrimental."

Dr. Godding, in an address before the National Conference of Charities and Corrections, thus spoke on this question: "The provision, then, should include one building, or preferably one group of buildings, designed especially for the acute and curable cases. No detail in construction should be omitted, no liberality of arrangement curtailed, that may be held to in any way assist in the treatment and cure of these cases."

The last fifty years have witnessed a work of which we have reason to be proud: the evolution of the care and treatment of the insane out of the mist and darkness of superstition and ignorance, when the insane were chained, beaten, and burned, to the present kindly care which seeks to treat them as very sick people. The

future, however, presents also a grand work to be accomplished: the elevation of this specialty to the highest scientific and philanthropic plane.

The duty of the State to the insane may, therefore, be summed up in—

1. The separate treatment of the curable and incurable insane under the same medical executive.

2. True hospital treatment for the curable insane with all the medical skill, nursing, and care, regardless of expense, which the character of the disease demands.

3. Simple, humane, custodial care of the incurable insane, at a moderate expense.

THE LIP AND EAR ORNAMENTS OF THE BOTOCUDUS.

By JOHN C. BRANNER, Ph. D.,
FORMERLY ASSISTANT ON THE GEOLOGICAL SURVEY OF BRAZIL.

THE Botocudus are a rapidly disappearing tribe of Brazilian Indians. They inhabit the country along the upper portion of the Rio Doce, about three hundred miles northeast of Rio de Janeiro, and the region lying along the borders of the States of Bahia, Espirito Santo, and Minas Geraes, especially between the Rio Doce and Rio Pardo, and along the Sierra dos Aymorés. Although they are now in contact with civilization and fast yielding to and dying out before its gentle influences, it is not many years since they and the various branches of their great family occupied a large portion of southern Brazil, and were justly looked upon as the most ferocious of all the wild tribes of that country. But few travelers have seen anything of them, and these have observed only the straggling outskirts as it were of their tribe. Even to this day the latest and best maps of Brazil have written broadly across the vast region referred to, "But little known, and inhabited by Indians." In these dense and almost impenetrable forests they spend their lives, seldom or never visiting either the *campos* of the interior or the coast.

To judge of the stage of civilization of these Indians it is worth while knowing that they can not count, and that their reckoning is done by using the fingers and toes, and that even this does not go beyond twenty. The children are dirt-eaters, and are sold for slaves, often for the merest trifles. Formerly these people wore no clothing at all; nowadays they are coming more and more to use it. Their straight, deep black hair, high cheek-bones, flat noses, complexion, and stature are all suggestive of the Mongolian race types.

It is not my purpose, however, to say much of the Botocudus

except with reference to their custom of wearing the large and broad lip and ear ornaments shown in the accompanying illustrations. Several travelers in Brazil have given figures of Indians using such ornaments, notably Spix and Von Martius, Maximilien Wied-Neuwied, Hartt, Jean de Lery, Bigg-Wither, and Von Tschudi. It may be said of the illustrations given by those writers, however, that they, without exception, fail to give the characteristic features and expressions of the Botocudus, or, for that matter, of any Indians. Those used in the present article, on the other hand, have been carefully drawn from photographs made a few years ago by M. Marc Ferrez, photographer to the Imperial Geological Survey of Brazil, and may be relied upon for their accuracy. The subjects chosen for the photographs were selected with a view to securing the best types that could be had, but it should be remembered that the Botocudus of to-day are rapidly approaching extinction, and that their customs are probably modified to a considerable extent since the visit of Spix and Von Martius, which was made in 1817 to 1820.*

FIG. 1.—BOTOCUDU WOMAN. The flesh band of the lip has been broken and the ends tied together with a piece of bark, that the lip ornament may be used. An opening has been made in the ear lobe, but it is not of the customary size.

The custom of wearing the lip and ear ornaments is a very ancient one among the Botocudus, for the earliest travelers found it in vogue when the continent was discovered. Hans Stade, who lived among the Ay-

FIG. 2.—BOTOCUDU WOMAN, with both lip and ear ornaments of average size.

* Rum has much to do with the wiping out of the native Indians of Brazil. The whites, especially the original settlers of the country, treated them without pity, enslaving them and killing them upon the slightest provocation or with no provocation whatever.

morés of southern Brazil in 1549, says of one of the chiefs, "Then he arose, and strutted before me with proud conceit, and he had a large round green stone sticking through the lips of his mouth as their custom is." *

The opening in the lower lip is made when the person is quite young by piercing it with a long, slender thorn that grows on a kind of palm tree; this is enlarged with the point of a deer's horn, and a stick or small stone is inserted and the wound is greased with some kind of salve. These openings are gradually enlarged by forcing bigger and bigger plugs into them until the desired size is reached. It was formerly the custom when the young men were old enough to bear arms that the openings were enlarged and the green stone labrets inserted.†

FIG. 3.—BOTOCUDU MAN. The ear ornament has been removed and the distended lobe is allowed to hang free.

Jean de Lery says that sometimes when these stones are out, just for the fun of it, they stick their tongues through the holes in their lips, to make people believe they have two mouths. He adds, "I leave you to judge whether they look handsome when they are doing this." ‡

The lip ornament is of two very different forms, only one of which—the broad and stopper-shaped one—is illustrated in the accompanying cuts; the other is long and rudely T-shaped. The shank or long cylinder is pushed through the opening from inside the lip and the cross-piece at the top prevents its falling out. The openings for ornaments of this kind are not nearly so large as those required by the stopper-shaped ones. Several writers tell of the use of stones for labrets. Jean de Lery * speaks of polished bone as white as ivory used by the big boys, and replaced when they are grown by green stones. I have seen many of them made of clay and burned like pottery, while the ornaments in most common use nowadays are made of wood.

There is a fair collection of Brazilian Indian lip and ear orna-

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* The Captivity of Hans Stade, of Hesse. The Hakluyt Society, No. li, p. 72.

† Hans Stade, p. 139.

‡ Histoire d'vn Voyage faict en la Terre dv Bresil, par Iean de Lery. Geneva, 1583, p. 104.

* *Op. cit.*, p. 104.

ments in the Museu Nacional at Rio de Janeiro. Many of the examples in the collection are beautifully finished specimens of jade, beryl, serpentine, and quartz, while others are but rudely shaped ones of burned clay and wood.

However strange and in a certain sense fascinating such customs may be, these ornaments, when seen in the ghastly wounds of the dusky, stolid faces of savages, are inexpressibly hideous. They are rendered still more so by the fact that the South American Indians, so far at least as my observations go, lose their front teeth early, and especially the lower ones, and the pulling down of the lower lip almost invariably exposes the toothless gums or the broken, decaying, discolored, and filthy teeth. Hunger is the curse of savage life, and the savage is therefore always on the alert for something to eat. For this reason the discharge of saliva is much more marked with a savage than with a civilized man. The effect of this free discharge of saliva on the personal appearance of a man or woman, whose lower lip is all the time drawn so low that it can not be retained, may be imagined more readily than described.

FIG. 4.—BOTOCUDU WOMAN. The ear ornament has been lost and the distended lobe is looped above the ear.

The stopper-shaped lip ornaments are now made of some light kind of wood. They are usually about three quarters of an inch thick and two inches in diameter, though sometimes they are much larger. Prince Maximilian measured one four inches across. Around the outside of the plug a little groove is cut, and when it is inserted the flesh band of the lip fits in this groove and thus holds the plug in place. With age the flesh bands relax considerably, and the plugs of old persons are for this reason generally larger than those of younger ones. When the ornament is removed the lip dangles in a most ungraceful manner. In the accidents of savage life these openings in the lips are often broken, but this does not prevent the wearing of the customary ornament, for the broken ends of the band are united by a string made of a bit of bark, and the plug thus held in place. One of the accompanying illus-

trations (Fig. 1) was made to show this method of sticking to the fashion.

The ear ornaments of the Botocudus are not essentially different from those used in the lips (see Fig. 2). The plugs are of the same materials, size, and appearance; they differ only in that they are worn in the openings made in the lobes of the ears instead of in the lower lip. The bands of the ears, when the plugs are not in place, dangle upon the shoulders when left to themselves (Fig. 3), but they are generally thrown over the top of the ear. This custom of looping up the ear lobes is shown in Fig. 4.

FIG. 5.—YOUNG BOTOCUDU WOMAN, AGE ABOUT SEVENTEEN. The ornaments worn in the ears are the modern pendants.

Many persons who have seen these pictures have thought such a fashion too inconvenient to last long. But the inconvenience of a fashion seems to have but little or nothing to do with either its origin or its perpetuity. Our own fashions are often complained of as tyrannical, unreasonable, unbecoming, inartistic, useless, whimsical, and everything else that is not downright wicked. But all people have fashions of one sort or another, and we can only congratulate ourselves that, however bad some of our fashions may be, they might have been worse than they are.

AMONG the reasons published by Count Paul von Hönsbröch, of Germany, for renouncing his allegiance to the order of the Jesuits, are the rigor and monotony of the discipline enforced by its rules. From the first day of his novitiate the young Jesuit, it might be said, is run into a mold from which he is ultimately to emerge a mere passive instrument of the mission work of the order. The mesmerized or hypnotized patient, according to the count, is not a more perfect tool in the hands of the manipulator than is the well trained Jesuit in those of the general of the order. He lives, moves, and has his being simply at the behest of his superior, and responds to the demands from those above him with a fidelity and an efficiency attainable under no other system. A similar confession is made by Count Campello, of Rome, in his statement of reasons for having ceased to serve as canon of St. Peter's. The daily monotonous exercises of the Basilica, repeated morning and evening without break from year to year, were paralyzing his mental and bodily powers and destroying all initiative. These facts point to a fatal influence of monotony which deserves to be studied; for under the increasing specialization of learning and occupation, life is tending daily to become more monotonous and more destitute of true inspiration.

CRIMINAL FESTIVALS.

By M. GUILLAUME FERRERO.

WHAT we now call crime is a normal fact of social life among ruder peoples, who have not yet risen above the lowest grades of manhood. Murder, theft, pillage, are glorious exploits or rarely sought-out amusements among such; and cannibalism is a system of alimentation more prized than all others. Primitive man in most regions has no repugnance against killing and eating other men, but rather finds enjoyment in it. This being the moral condition of most primitive peoples, we can comprehend without difficulty that their festivals had a cruel and criminal character. As human flesh is the most exquisite viand for cannibal savages, it was natural that when they met to celebrate any welcome event in a festal way they should regale themselves liberally with this precious food. The Fijians never failed in their cannibal days to mark every public solemnity, like the dedication of a temple, with a grand feast of human flesh: and they celebrated their victories in war by carving and roasting their slain enemies on the field of battle. The Monbuttos celebrate grand man-eating festivals on the field of battle after a victory. The New-Zealanders carved up immediately after the battle their vanquished and wounded enemies, while prisoners were reserved, partly to be eaten by the braves, and partly for grand public festivals in which human flesh was the principal dish.

Murder is a pleasure to the primitive man, as with the Javanese, who tests the quality of his new dirk by plunging it into the heart of the first man he meets. It is quite natural, therefore, that there should be meetings among these people for the enjoyment of this pleasure, at which they engage in murderous festivities at the expense of some unfortunate victim. The red Indians, returning from an expedition, used to give themselves up to sanguinary orgies upon their prisoners, binding them to a stake in the midst of the village, when men, women, and children would inflict petty tortures upon them till they died, killed by pin-prickings.

We see, then, that in the beginning of civilization crime is individual and collective; there are crimes which each man commits on his own account, and criminal festivals, collective crimes, perpetrated by a whole tribe, a people, etc.

The same rule prevails with those very numerous crimes which are connected with religious ideas, such as human sacrifices in honor of defunct ancestors and then of the gods, who are only deified ancestors. Among so savage peoples, these ancestors would have been fierce and cruel men, to whom human sacrifices, kill-

ings, and massacres would be supposed by their adorers to be pleasing; in fact, the Tahitians believed that their god Oro was very well satisfied when wars were bloody; and the Chibchas said that no sacrifice was so dear to the gods as sacrifices of human blood. For this reason many were killed among the most savage peoples in honor of ancestors and the gods. These religious crimes, too, were individual and collective—that is, the sacrifice was sometimes performed by one man, sometimes by a family, and sometimes by a whole tribe, according as a personal, a family, or a tribal concern was to be commended to the gods.

According to this view, we should be tempted to believe that when crime began to be the object of legal repression and moral repulsion, all these individual and collective crimes, festivals, and human sacrifices would disappear. It is not so. By a curious contradiction, individual crime has disappeared sooner than collective crime. The branding by the public opinion of peoples who have become sufficiently civilized, of murder, theft, and cannibalism as offenses, may have prevented individuals from committing them, but did not prevent the whole people celebrating the criminal festivals which their savage customs had engendered, although they were contradictory of the changed condition of public morality. In fact, we find among very civilized peoples official festivals and ceremonies which are wholly worthy of the most savage races.

It is a general belief among primitive peoples that human blood, possessing marvelous qualities, assures fertility to the fields and stability to houses, and on that account a large number of homicides are committed among such peoples: for each man tries to assure the benefits of bloodshed to his own fields or to his house. Among the civilized Aryans of India this barbarous custom existed no longer; whoever killed a man to use his blood for such a purpose would have been condemned as a murderer; but the ancient usage still survived in public ceremonies.

War is often made by primitive peoples for the purpose of eating the enemy who is slain, for the enemy is then only a special kind of game. With some peoples who have advanced a little, and who have abolished their cannibalistic customs, we find that human flesh is the essential dish in certain banquets celebrated in honor of victories. In Dahomey, after fortunate wars, there were public festivals in which banquets of human flesh were a sacred custom, although the Dahomeyans were not cannibals; and it was the king's function to eat the heart of an enemy's chief slain in war.

What is called *juridical* anthropophagy occasionally gives rise to a peculiar species of criminal festivals. Among the Battas of Sumatra, a numerous people, agricultural, peaceful, and law-

abiding, who have a regular system of laws, an alphabet and a literature, and are not cannibals, the adulterer, the night-robber, and those who traitorously attacked a city or a village, were condemned to be eaten by the people. They were tied to three stakes, their arms and legs stretched out to form a cross, and then, at a given signal, all those present would rush up to them and hack them up with hatchets and knives, or simply with their nails and teeth. The torn-off pieces of flesh were eaten at once, raw and bleeding, being first only dipped in a mixture composed of citron-juice, salt, etc., prepared in advance in a cocoanut shell. In adultery cases the husband had the right to choose the first piece.*

The Dyaks have a criminal festival associated with the peculiar custom of head-hunting. Since in many tribes a young man can not marry till he has presented a human head to his sweetheart, he hides himself in the shrubbery of the jungles and watches for his victim for days at a time, till he kills him and cuts off his head. Then he returns to his village and announces his triumph by blowing upon the sea-shell that serves him as a hunting horn; the children and the women come out to meet him, give him an ovation, and lavish upon him the most exaggerated and hyperbolical praises; and the bleeding head is borne in great pomp to the house of the chief. Before hanging it up in front of the dwelling, children are caused to suck its blood, in order that they may draw courage from it. Yet the Dyaks are a peaceful people, for homicide is very rare within their tribes. "Not the thirst for carnage, or the love of murder," writes Temmink, "or any spirit of vengeance, induces them to cut off heads. They are not anthropophagic. A hereditary superstition, passed into a custom, causes them to commit acts which they believe to be meritorious." In fact, the Dyaks, like the Battas, have an undisputed reputation for sincerity, frankness, and honesty.†

It is especially religion that gives its sanction and consecrates these collective crimes, by preserving them in customs associated with its dogmas and rites. The Phœnician race, even when it had reached the highest degree of its civilization, still retained human sacrifices at Tyre, Sidon, and Carthage. The festivals of Moloch were real orgies of blood; the priests burned children in honor of the god, and the people, excited by the spectacle, were seized with such an agitation that many men were injured by the frenzied crowd. These horrors were repeated at Upsala by the Scandinavians, and at Rügen and Roncova by the ancient Slavs; yet the Scandinavians and the Slavs, although they were not so

* Letourneau, La Sociologie d'après l'Ethnographie, Paris.

† Bertillon, Les Races sauvages, Paris.

civilized as the Phœnicians, were people who had made considerable advance. Still, this is not so astonishing as to find human sacrifices in use even among the Greeks, with whom in the period of their grandeur the throng, at the mysteries of Bacchus Zagreus, cut up a goat, a sacrifice which was only a substitution; for anciently, according to Plutarch, it was a man that the throng cut to pieces on the altar of Dionysos Omostes—Dionysos, the flesh-eater. At the Thargelia, the Athenians gayly decorated a man and a woman who had been entertained at the expense of the state, escorted them in procession, and burned them at the entrance to the plain. The Celts bought slaves, whom they entertained liberally, and at the end of the year conducted in great pomp to the sacrifice. Every twelve months the Scythian tribe of the Albanians, according to Strabo, fattened a slave whom the people then massacred with lance cuts before the shrine of Artemis.

The great solemn popular festival of the Khonds included the annual immolation of a victim. After three days of indescribable orgies, in which women often participated dressed like men and armed like warriors, the victim was bound to a stake in the midst of the forest, and left there all night alone; in the morning the people returned, with a great noise of bells and gongs, singing and shouting; when the multitude had become well intoxicated with the uproar, and greatly excited by disorderly dances, the grand priest would command silence and recite a long prayer, and would then slay the victim, usually with a single stroke of the knife. The multitude, which had been waiting for that moment, rushed upon the quarry with piercing cries, each one trying to tear off a piece of the palpitating flesh, to hack the body to pieces.

A criminal ceremony exists among the tribes of the interior of Sumatra, which is without doubt the survival of an ancient and very cruel custom, that has passed in the course of time into a civil and religious duty. These people, although of rather gentle disposition, piously and ceremoniously kill and eat their aged parents, in the belief that they are performing a sacred duty. At the appointed day the old man who is destined to be eaten goes up into a tree, at the foot of which are gathered the relatives and friends of the family. They strike the trunk of the tree in cadence and sing a funeral hymn. Then the old man descends, his nearest relatives deliberately kill him, and the attendants eat him.

With some peoples animals take the place of human victims; but what we have said is sufficient to show that even with these peoples collective crime was formerly a solemn ceremony, although individual crime was already regarded as something to be condemned.

Till very recent times the people of Ispahan celebrated what they called the festival of the camel, or of the sacrifice of Abraham. The high priest of Mecca sent his adopted son, mounted on a blessed camel, which was led through the city with great pomp. At a given moment the king shot an arrow into its flanks; in a wink the poor animal was thrown down, hacked to pieces, carried off, and distributed widely. Every one wished for some of it, if it were only the smallest fragment, to be put into a kettle of rice. The Ghilicks and the Ainos adopted a bear, and fed it freely till the day of the public festival, when the people struggled for pieces of it.

Sometimes, in these criminal festivals, the public only plays the part of a spectator. It does not itself kill the victims, but only witnesses the slaughter, the bloodshed, which executioners are commissioned to perform. In Etruscan funerals the relatives of the deceased caused a convict to be publicly tormented: sometimes they blindfolded him and gave him a stick; then the executioners excited dogs against him, and the unfortunate victim had to defend himself with his stick. Such spectacles, which seem to have been amusing to the populace, are represented in many Etruscan paintings. The shows of gladiators at Rome, fights of gladiators with one another, and of gladiators with wild beasts, were simply transformations of the funeral sacrifices of the Etruscans, but more ferocious, for they generally ended in the death of a large number of men. The passive Roman people had such a passion for these games that they became a means of political domination; parties sought to secure the votes of the populace by giving them spectacles in which large numbers of men and beasts were killed.

In ancient Mexico, where crime was punished very severely, and was pursued with much energy, an immense throng came together every year to witness the numerous and terrible human sacrifices in honor of the god Huitzilopochtli. The spectacle, with its atrocious cruelties, was a source of delight to a people among whom intoxication, theft, and murder were punished with death, and who possessed a remarkable political organization and civilization. This transformation of the populace into spectators was, without doubt, an advance; but it is nevertheless surprising that such ceremonies should have been tolerated among peoples so civilized.

We see, therefore, that collective crime has opposed a greater resistance than individual crime to the progress of civilization. But why have these criminal festivals endured so long, while individual customs have been undergoing transformation? "The axiom, the whole is the sum of its parts, does not apply to multitudes," writes M. Reclus. M. Sighele has brought a large number of proofs to the demonstration of this precept—that is, that the

aggregate of many men presents some characteristics that are not found in the unities that compose it.* The psychology of a multitude of men is a special psychology; for the passions, the inclinations, and the thoughts of the individuals who compose it are combined in such a way that the conduct of a man mixed with a crowd will be quite different from that which he would observe if he were alone. The phenomenon we are studying is the effect of a similar difference between the characters of an aggregate of men and the characters of its units. A crowd of men is always more afraid of the new, more conservative, than are the men who compose it. For that reason a usage is more stable and less subject to variation in proportion to the number of men who observe it. The larger the multitude grows the more intense does its misoneism (hatred of novelty) become.

Every one can observe that it is easy for a man to change his individual habits, but that the habits of a family, being more fixed, are changed with greater difficulty. In fact, in some families there are ways that are preserved for two or three generations. But fixed as family customs are, they are unstable enough if we compare them to the usages of large aggregates, to the whole population of a city, for example. In all Europe, in Italy, France, and Germany some of the cities still celebrate the festivals of the middle ages, occasionally even Roman festivals, which plunge a whole population every year into the past again. The costumes, the banners, and the signals, everything in these festivals is old, and no one would be satisfied to use anything modern in them, for all their beauty would then seem to vanish. We find yet more superannuated usages when we consider still larger human aggregates; for while in the usages of a city we find survivals of its history, in the usages common to all civilized men we find survivals of the ancient primitive life, customs which appertain to the savage period. Of such, for example, is the worship of ancestors; for that exists no longer among peoples of high civilization, and rites relating to it have been nearly entirely abandoned. Yet these rites, which exist no longer in individual practice, still survive as a general usage among all Roman Catholic peoples, for the ceremony of the day of the dead is nothing else than a survival from the ancient ancestral religion. On that day all turn back in a mass to perform acts relating to that religion—visiting of the graves, renewing of the floral crowns, etc.—like those we find in use among savage tribes, although no thought or notion of the worship of ancestors is left among us. What does not exist as an individual practice still survives as a general usage.

* La Foule criminelle, Paris, 1892.

A mass of men is thus always more afraid of novelty than the men that compose it: these may change their feelings and their ideas, but they come together; the feelings and ideas acquired by the individuals will have no influence, or but little, upon their conduct. What is the cause of this contradiction? Why is a mass of men always more conservative than its components? Man, according to the law demonstrated by M. Lombroso, hates all novelty and tries to preserve everything that exists—his ideas and feelings—so long as he can, without changing them. Yet, when very strong necessities urge him, man succeeds in disturbing his inertia: he changes his habits and his ideas, and rebels against institutions and laws which he had once venerated; but it is always a painful task, a disagreeable effort for every man, even the best endowed, to carry this revolution into the system of his ideas and habits. Difficult as this change may be for each man, it is still more so when a collective usage is concerned; for then the opinion of all the other men to the same effect and imitation re-enforce the neophoby (or fear of novelty) natural to the man. The struggle is not only against one's own conservative instincts, but also against the fear of being alone in neglecting a usage which all others observe. "Everybody does it," is the answer most persons will give you when you ask them why they practice some quite absurd and ridiculous ceremonies. Further, no one has any particular interest in these collective usages, and therefore no one has special reasons for abandoning them; for these usages to pass away there must, therefore, be causes acting upon the whole mass of those who observe them, producing gradual decadence. Now these causes would naturally act more slowly than those which produce individual changes of manners, ideas, etc.; they will act more slowly, too, as the aggregate of men subject to their influence is greater.

So the genesis of criminal festivals is explained. When crimes become the object of legal repression and then of moral repulsion, men begin, each on his own account, to abstain from committing them; their views in relation to criminal actions gradually change, and those acts which formerly appeared honorable and glorious become gradually blamable. But these criminal festivals, to which the ancient liberty and the ancient glory of crime have given rise, being usages common to a whole tribe or people, enjoy the advantage of the greater stability we have remarked in collective usages. Each man removes himself slowly from crime but to return to it, as a member of the tribe, when the time for these civil or religious festivals of a criminal character returns. Thus, the Dahomeyan, who is no longer a cannibal, becomes an anthropophagist again in the great public festivals that are celebrated after a victory; the East Indians slay men upon the

foundations of a palace, but only when great public edifices are a-building; and the inhabitants of Sumatra, gentle enough in their ordinary customs, solemnly eat their old men, in the belief that they are thereby observing the most sacred of their duties as sons.

There is a still more curious side in this strange phenomenon. Everything old and superannuated—usages, customs, laws, etc.—is the object of an extreme veneration, especially among primitive peoples. The Tupis believed that if they should depart from the customs of their ancestors they would be destroyed; in some clans of the Malagasy innovation and evil are inseparable ideas; the Araucanians have many very ancient usages which they hold sacred and observe without any constraint; the Hottentot-Koramas are entirely free in their actions, except when ancient usages are involved. Since these criminal festivals survive long after crime has begun to be a morbid exception, they end by becoming sacred, profiting by the veneration attached to all ancient things; to abolish them or neglect them would be for these peoples a failure in the holiest duties. Consequently, the deed, which appears horrible and worthy of punishment when it is done by a single man, is regarded as honorable when it is performed by the whole tribe or the whole people in these festivals; the crime of the individual becomes the duty of the mass.

These sanguinary festivals have been able, by the effect of another cause, to endure long, even among superior peoples, like the Greeks and Romans. Unfortunately, crime, especially murder and crimes of blood, is not an action of which man has an innate horror; horror of crime, when it exists, is only the effect of a long training, of a painful education of civilization. Murder, M. Taine writes, introduces two extraordinary emotions into the moral and animal machine of man, which overturn it: on the one hand, the sense of all-power exercised without control, obstacle, or danger, on human life and on sensible flesh; and, on the other hand, the sense of bleeding death with its always novel accompaniment of contortions and shrieks. That is why all those who can dispose at their caprice, without any danger, of the existence of other men—kings, princes, and mobs—are usually inclined to cruelty. This tendency to the sanguinary pleasures of murder would be more lively among half-civilized peoples, who have been only a little while accustomed to respect for human life; and therefore criminal festivals, although contradictory to the state of individual manners, would be a choice amusement for them; for all the ferocious instincts which usually slumber in the man could give themselves free course in them. It explains to us, too, why men have tried to preserve these festivals by ameliorating them, when civilization would not tolerate their primitive feroci-

ty; when human sacrifices became impossible, animals were substituted; when combats between men seemed too horrible, fights of animals—of cocks, bulls, and fishes—were instituted. It has been said that the minister who should try to abolish bull fights in Spain would provoke a general revolt. In these cases the multitude are only spectators of the carnage; but when a people like the Spanish loves these sanguine representations with so furious a passion, can we be surprised that people less civilized ardently lust after the pleasures of collective criminality, although their manners may be in course of amelioration?

Besides having a historical interest, the study of these criminal festivals is very important for criminology, because it brings numerous evidences in support of the atavistic theory of crime. In discussing the questions whether crime is a phenomenon of atavism, or whether at least atavism does not play a considerable part in criminality, many criminologists have maintained that while most savage peoples are thieves, cruel and dissolute, nothing authorizes the affirmation that the ancestors of civilized peoples resembled them. We have, indeed, no direct proof of this fact; but if, in default of proof, we examine the usages and institutions of these peoples, which are a kind of fossil remains of their evolution, we may conclude that the primitive ancestor of the Greek was no more moral than the Australian or the Javanese. These criminal festivals can be explained only by assuming an ancient condition of moral disorder; which admitted, everything becomes clear, and is susceptible of a simple and logical explanation.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

THE prevalence of lake basins in glaciated countries is accounted for by Mr. J. C. Hawkshaw by assuming that whenever earth movements take place in limited areas they will tend to form basins. Since such movements are as a rule gradual, the basins will tend to fill up with water-borne detritus, the growth of vegetation, etc., as fast as they are formed. In glaciated countries, however, they are occupied with ice, and that protects them from being filled up by such processes, and they will be preserved to appear as lake basins when the ice melts. Such basins are probably more numerous in rainless countries than we are aware of, for, not containing water and not presenting a different appearance from the rest of the country, they do not attract attention. An instance of them is presented in the Raian basin of Egypt, which has been surveyed by Mr. Cope Whitehouse, with a view to making use of it in works of irrigation.

A SERIES of Roman tools, more than sixty in number, discovered in a rubbish pit during excavations at Silchester, England, in 1890, are described by Sir J. Evans. Among them are anvils, hammers, chisels, gouges, adzes, axes, and a carpenter's plane. The find also included two plow-coulters, a sword-blade, a large gridiron, a lamp, and a bronze steelyard.

THE URAL COSSACKS AND THEIR FISHERIES.

By Dr. N. BORODINE,
FISH COMMISSIONER OF URAL DISTRICT, RUSSIA.

THE Ural Cossacks, who live on the boundary between European Russia and Asia, along the middle and lower part of the Ural River, have been known in Russia for a long time, not only as brave soldiers in war time, but also as peaceful fishermen, carrying on the fishing industry on a very large scale and in quite a peculiar manner.

More than three hundred years ago the first band of the so-called "free people"—Cossacks—appeared on the *Yaik* River, the original name of the *Ural* River.*

Who were this people? They were pioneers of liberty, people tired of cruel serfdom and discontented with subordinate life in Russian czardom, who tried to organize their life on a basis of absolute freedom and after their own ideas in the vast steppes of southeastern Russia.

The free colony grew rapidly, thanks to large additions of discontented people from all neighboring provinces of Russia and from foreign countries. A careful examination of an early census of the Ural Cossacks made by order of Peter the Great (1723) shows us that among the immigrants were Poles, Hungarians, numbers of peasants from different parts of Russia, many dissenters from the Russian Orthodox Church, prosecuted by government, a great number of Don Cossacks, etc. Differing in nationality as well as in language, one thing was common to all, the ardent longing for freedom and independent life. Is it not a counterpart of the earliest period of immigration to this country, when those who were persecuted in Europe sought freedom elsewhere? An old Cossack, when asked once about the origin of the Ural Cossacks by a well-known folklorist, answered, "The bee gathers from every flower its best, and what is the result?"

"Honey," replied the astonished man.

"Well," said the Cossack, "in such a manner grew our community: from everywhere came the best and brightest men and organized our society."

Do not you think that this simple and witty simile well illustrates the history of early colonization in this country as well as the origin of the small community of which I speak?

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* The names of *Yaik* River and *Yaik* Cossacks were changed to *Ural* River and *Ural* Cossacks by imperial order in 1775 after Pugachevk's rebellion, in which the Yaik Cossacks took a very active part, the order stating that the old name should be abolished and entirely forgotten.

Fig. 1.—A Street in Uralsk.

In 1580, we read in a historical document, came to the lower part of Yaik River a band of Cossacks and expelled from the country the remainder of a once famous and strong Gold-Horda of Tartars. They ruined Saraitchik, the chief residence of the Tartars, and sailing up the river, founded a fortress near the place where is now situated Uralsk, the chief city of the Ural Cossacks.

At first these warlike bands lived by a rather peculiar industry —marauding of hostile neighbors (Tartars) and sometimes commercial ships on the Caspian Sea *en route* from Khiva and Persia.

"Ah, formerly we Cossack fellows
Sailed pretty well on thy waves,
In light boats looking for prey,
For the prey from Khiva and Persia,"

says one Cossack song about this old time.

It is difficult to say when the Ural Cossacks changed this industry for the more peaceful one of fishing. Probably this was

Married woman. Old woman. Girl.

FIG. 2.—TYPES OF URAL COSSACK WOMEN.

very soon after the conclusion with the Muscovite Czar of a kind of protectorate (1613), which is commemorated by a peculiar old custom of presenting fish and caviar from the community to the imperial court. This custom, sanctified by more than three centuries, exists yet, and was doubtless a token of loyalty and hospitality similar to the custom of the Russian agricultural population of presenting bread and salt on like occasions. As the Russian peasant poetizes his hard agricultural labor and surrounds it with

an aureole, so the Ural Cossacks poetize their fisheries and everything in connection with them. In almost every popular song of this country is mentioned, under all kinds of poetical names, the Ural River with "its golden bottom" and its "silver banks," and one of the most favorite local songs is an ode or hymn in honor of the Yaik River (the historical name remains in poetry), the foster father of the population. The economical importance

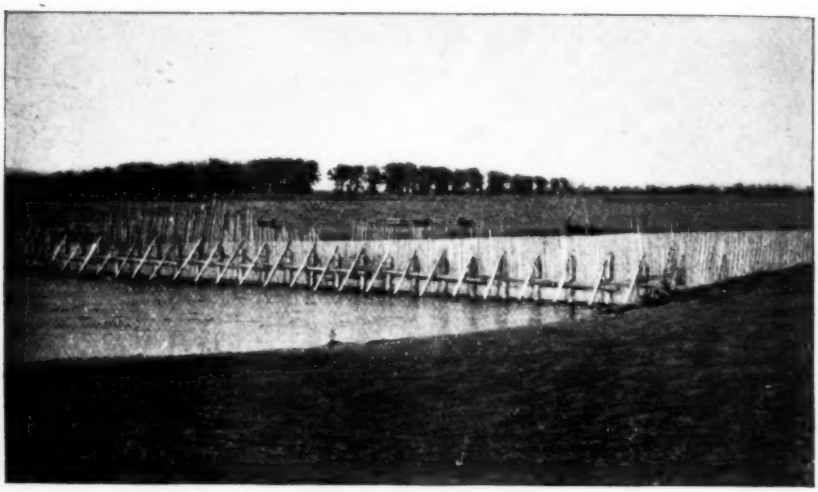

FIG. 3.—RAILING ACROSS THE URAL RIVER.

of the fisheries for this people is so immense that it influences their whole life, not excepting the military service. The right of fishing in communal waters does not belong to any but members of the community, who, on the other hand, are compelled to undertake military service. The Ural Cossacks have ready for the service every year about three thousand cavalry, and in case of war every adult may be called on to serve as a soldier. The entire population is about one hundred and ten thousand souls.

Thus, when one part of the men is engaged in military service, the other part, which remains at home, is forced to procure money to pay the expenses of equipment for the outgoing soldiers, and also to make their own living.

Only by bearing this heavy double burden have the Ural Cossacks succeeded in acquiring exclusive rights to the land and river colonized by them, and to preserve until the present time some independence in their home affairs with a peculiar economic organization of the community as an entire body. Much struggling and fighting was done in the early existence of this small community in order to gain this measure of independence from the Muscovite Government, which has always had a strong tendency to centralize different parts of Russian territory under

one absolute power. From its early existence until 1723 the community was entirely independent in its interior home affairs. It was a purely democratic republic, with an elected chief, or *ataman*, representing the executive power. All governmental affairs were transacted in a communal "circle" or general meeting of the members of the entire community. In 1723 the Russian Government first laid its hand on the independence of the community, and since that time the election of the chief must be approved by the Government in order that the appointment may be legal. In 1775 the communal "circle" was abolished and the community entirely lost the right of electing its *ataman*, who since that time has been appointed by imperial order. The only thing still remaining is the economic organization, where the independence is very characteristic.

To return to the fisheries and their importance in the life of the Ural Cossacks. I should mention that the Ural River is the

FIG. 4.—FALL FISHING ON THE URAL RIVER. CARTING BOUDARAS.

only large river that is entirely given over to the fishing industry, all sorts of commercial navigation being absolutely forbidden from Uralsk to the Caspian Sea (three hundred and thirty miles); and more than that, in some places of the river, where sturgeons collect for their winter sojourn, no one is permitted to run a boat, to make any noise, build a fire on the shore, etc. By the laws of the community summer fishing is almost entirely prohibited, for the purpose of protecting the spawning, also for the reason that fish caught in summer will not bring a good price.

They let fish enter the river from the sea and settle there quietly for the winter sojourn. All possible means are used to secure for the fish an unrestricted passage to the upper parts of the river, but not beyond Uralsk, where a railing is constructed across the river to prevent the larger fish going farther up. Owing to this arrangement the lower part of the river from this railing to the mouth forms a large natural fish pond (three hundred and thirty miles in length) where the fish are carefully watched by a great many fishwardens until the regular time for

FIG. 5.—FALL FISHING ON THE URAL RIVER. WAITING FOR A CANNON-SHOT SIGNAL.

fishing, which is fixed by general consent of the community. It is easy to understand what a thorough organization is necessary to conduct successfully this complicated plan for the distance of three hundred and thirty miles, and which has to deal with more than ten thousand fishermen. It is indeed a complete organization. The central administration, residing in Uralsk, controls all this business, assisted by numbers of local agents through the whole country. A steam cruiser, steam launch, and a number of sailboats constantly watch the mouth of the river and the neighboring banks and protect them from poachers. It should be mentioned that the river, with its fishing grounds and part of the Caspian Sea, belong to this entire community, consisting of a hundred and ten thousand people. There is no private property belonging to individuals or villages adjacent to the river, and an elaborate and detailed general plan must exist to regulate all this immense business in such a manner that the interest and rights of every member of the community shall be properly protected.

FIG. 6.—FALL FISHING ON THE URAL RIVER. SEINING ON THE FISHING GROUNDS.

The community does not believe that these interests may be protected by free competition, as is the case elsewhere.

As a rule, one part of the river (the lower) is intended to be fished out in the fall, the other (upper) portion in winter. The fall fishing begins about the 17th of September. On a certain day the "fishing army," as it is called, moves to the fishing places, which are sometimes very far from home. The Cossack carts contain not only nets and provisions, but also the boat used in this fishing. These boats, known by the name of *boudara*, are so light that two of them may be carried on one cart.

When the "fishing army" comes to the proper place, the boudaras are taken from the carts, and early in the morning appointed for commencing fishing they are placed at the edge of the water, right along the river for a distance hardly compassed by the eye. No less than three thousand boats, each containing two men, meet here. To maintain discipline, a chief, or "fishing ataman," is appointed, and several representatives of the fishermen are elected to assist the chief. The ataman gives a signal to commence fishing by a cannon shot, and then the crowd rush to the boats, and in less time than you can realize what has happened all the fishermen are in their boats and a peculiar kind of boat racing commences. They put forth their utmost strength and ability to outrun each other, and to be first at the place where the fish have gathered in shoals, these places being known by the reports from the fishwardens. Once here, they throw out their small seines and haul them from two boats. Various kinds of sturgeon (from thirty to six hundred pounds weight), sander, carp, bream, and silurus are the principal fish caught at this fishing. The seines differ, of course, in the size of their meshes, according to the fish for which they are intended; but no one has the right to use any but the regular size, large seines being admitted only behind the "fishing army." Hence, as in a noble fight, the chances of all combatants are as nearly equalized as possible by the regulations above mentioned, fixed place and time, regulated tools, etc. Success depends only on the ability and strength of the fishermen.

The total catch during the fall seining is from fifty-four million to seventy-two million pounds, which includes two hundred and sixteen thousand pounds sturgeon and about twenty-one thousand six hundred pounds caviar.

When fishing, the fishing army always goes down the river, covering from twelve to twenty-four miles a day, and in this way moves after a time to the mouth of the river, which is reached, as a rule, at the end of October. At this time the ice begins to accumulate in the river and closes the fishing season.

Another army of equal magnitude, consisting of fish dealers with a large number of carts, accompanies the fishing army.

These carts are contracted to carry the catch to the city markets (there is no railroad in this steppe). No less than ten thousand carts are used here, and if you add ten thousand more carts belonging to fishermen, you may imagine how imposing must be the sight of the peaceful armies.

The fishing in the upper part of the Ural River, as I mentioned before, is carried on in winter, under the ice, and that is the most peculiar of all fisheries. It is called *bagrenie*, which means "hooking," because the fishing is accomplished by a peculiar kind of hook. When the ice in the river becomes firm enough to support the weight of the fishing army, which generally takes place in December, an order is given by the communal administration for the army to meet at Uralsk, from which point the fishing is begun. On a fixed day, thousands of people, old and young, hasten to the appointed place.

FIG. 7.—URAL FISHERMAN READY FOR THROUGH-ICE FISHING, CALLED BAGRENIE.

Let us now see how the fishermen dress for this winter fishing. One of them ready for work is represented in the picture. Light and comfortable garments, waterproof mittens and boots; in one hand a chisel, in the other two haft-hooks—the long one (with a haft of seven or more fathoms) is used for catching fish, lying (as a rule) in deep places on the bottom; the short one is destined to hold the fish when it is brought to the surface of the ice.

At about 9 A. M. the banks of the river, near the place where the shoals of fish have gathered, are crowded with thousands of horses and sledges, so that it becomes difficult to reach the river. Fishermen go down to the ice and stand on it in endless lines on both banks of the river, anxiously waiting for the signal—a cannon shot.

The ataman has gone out in midstream; every one is looking for him impatiently. The signal having been given, two living waves of people rush forward to the middle of the river, and the

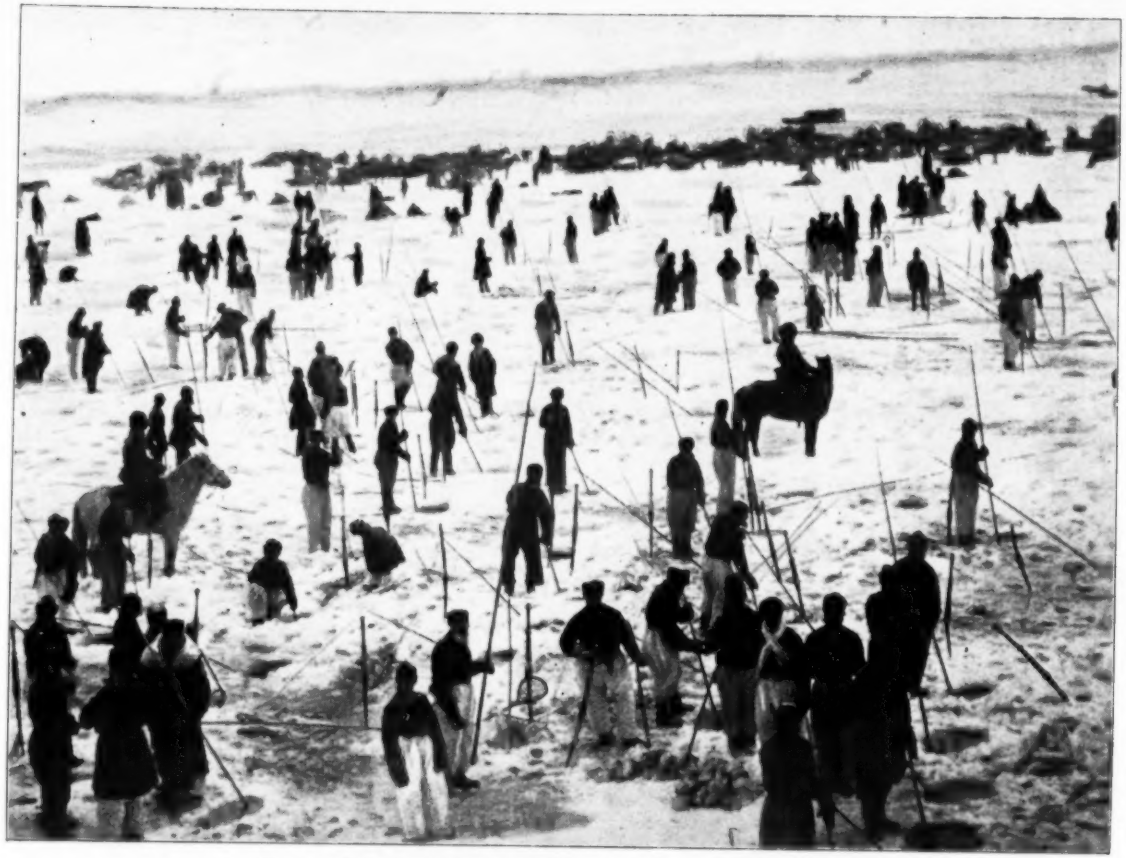

FIG. 8.—WINTER FISHING ON THE URAL RIVER, CALLED BAGRENIE.

arduous work begins, every one trying to be the first to make a hole in the ice with a chisel. In a few minutes an entire forest of long hafts grows up over the river, as though some magic power had been at work. The fisherman moves the haft up and down, and listens intently that he may know when the fish touch the hook. Once this has happened, he hooks the fish by an alert movement, then hauls it immediately up to the surface of the ice, calling in the mean time for help from his fellow fishermen. They fish here, usually, in groups of from six to twenty men, for it is not easy work to pull up a huge sturgeon of several hun-

FIG. 9.—FALL FISHING ON THE URAL RIVER. DRESSING FISH BY NATIVES.

dred pounds weight. In a very short time the surface becomes marked with blood and covered with big fish.

The most important fish caught in winter are different kinds of sturgeon, viz., the large sturgeon (*Acipenser huso*), Russian sturgeon (*A. Guldenstädtii*), star sturgeon (*A. stellatus*) and *A. Shypa*. Each decidedly differs from the other and from species caught in America. For the flesh and particularly the roe (caviare) very high prices are obtained in the winter season; one single big female of the "large sturgeon" is sold for 100 to 200 rubles ($64.50 to $129).

Of course, not every one succeeds in catching such a valuable fish; on the contrary, many, in spite of great efforts, do not catch any, not even the smallest sturgeon. Nevertheless, this fishing being an alluring lottery with winnings, everybody hopes to be a lucky one, and this is the reason why so many of the Ural

Cossacks attend this favorite winter fishing. Not less than ten thousand people participate in it; about a million and eighty thousand pounds of sturgeon and the same amount of other fish (sander and silurus) are caught and fifty-four thousand pounds of caviare prepared. The average price for sturgeon is 13·8 cents a pound, and for caviare about a dollar and a half a pound.

In addition to the fisheries described above, the Ural Cossacks carry on important fishing in the Caspian Sea in spring and also in winter; the methods not being of an unusual character, I omit a description.

The total amount of the local fishery business can be expressed in the following figures for 1891: 5,817,464 pounds of

FIG. 10.—FALL FISHING ON THE URAL RIVER. MAKING CAVIARE.

sturgeon, 73,960,824 pounds of other fish, 1,076,076 pounds fish roe, 173,348 pounds dried sturgeon steak (*balik*), and 6,084 pounds isinglass were exported from the territory of the Ural Cossacks. The total amount of fish landed must have been larger than these figures, owing to the local consumption, though in comparison with that exported it is quite insignificant. Thanks to the duty for every pound of fish exported from the Ural Cossacks' land, local fish trade statistics are excellent, and we are in possession of very valuable figures, similar to the above, for more than half a century, which gives an exact idea of the direction, increase, and decrease of this important industry in a very large and definite region.*

* The diagram is to be seen in the Russian Department of the Fishery Building at the World's Fair.

The revenue from the exported fish is used for different public expenses, and among others for the improvement of local industries in general and the fisheries in particular. Thus, during the last three or four years, a very fine agricultural school, with a model farm, has been erected at a cost of more than one hundred thousand dollars. They have several scholarships in the leading universities of the empire, and maintain a very large high school. For the purpose of making improvements in local fisheries a person of suitable education and familiar with home fishery affairs is sent to foreign countries to study the different branches of fishing industry, including pisciculture. I have the honor of being charged with this task. Two years are spent in these studies in all places of fishing importance in the different countries of Europe and North America, and now I have completed them by getting information at the World's Fair.

The Ural Cossacks' community is represented, although not largely, at the World's Fair, in the Russian department in the Fishery Building, and I should be much pleased if the foregoing could call the attention of visitors to the peculiar fisheries of my fellow Cossacks.

At the same time I would like to give some idea of the home life of this strange race, who are known in foreign countries only as a semi-barbarous, warlike people on horseback with formidable lances, etc. The foregoing, I hope, will add something new to their characteristics.

THE PROGRESS OF PSYCHOLOGY.

By Prof. JAMES McKEEN CATTELL,
COLUMBIA COLLEGE.

FOUR hundred years ago it was possible for Columbus to discover a new world. The circle of the earth is long since complete, but in the presence of each man is an unexplored world —his own mind. There is no mental geography describing the contents of the mind, still less is there a mental mechanics demonstrating necessary relations of thought. Yet the mind is the beginning and the end of science. Physical science is possible because the mind observes and arranges, and physical science has worth because it satisfies mental needs. The mind being thus the center from which we start and to which we return, there is reason for wonder that we know so little concerning it. Each of the physical and biological sciences includes a large mass of facts admitted by all students, and many theories which by general consent are accepted as working hypotheses. In psychology, on the other hand, there seems to be no common

ground continually increasing. The text-books contain speculations which are unverifiable, and often have little to do with psychology. They include descriptions of things which no one could understand from the description, but which every one understands without it. There are often anecdotes, which belong to the nursery. Then, in more recent times, we find accounts of the eye and brain, which are sometimes good physiology, but which seldom increase our knowledge of sensation and thought. It may be added that in the popular mind psychology consists largely of ghosts and mesmeric exhibitions.

But in the midst of confusion there are signs of order. Psychologies are now written which do not range at large through metaphysics, logic, ethics, and æsthetics, or, if they do, the writers at least know where they are wandering. Description and analysis become of greater value as introspection is more careful and words are more exactly defined. When works on physics, physiology, and pathology are sifted, there is found to be a considerable remnant which belongs to psychology. Even "telepathy" and hypnotism contribute their modest quota of facts. Comparative zoölogy, anthropology, philology, history, and art discover interrelations with psychology. Lastly, the attempt has recently been made to apply the methods of natural science, and even the measurements of exact science, in the study of the mind.

The backwardness of psychology is not indeed surprising. Certain material needs must be satisfied before there is time for self-observation. Even the lower animals are concerned with the changes of day and night and the return of summer and winter, with the growth of plants on which they feed and the habits of beasts which prey upon them. Astronomy, physical geography, botany, and zoölogy have their first foundation in remote, prehuman times. When the savage appears, he needs must attend to the external world, whereas self-observation would profit him but little. If his life depend on killing a bird with a stone, he must know the habits of the bird, and even something of the course of projectiles. Should he stop to consider the relation between sensation and movement, he would not survive to tell his thought. Even nowadays, when every one must have exact knowledge of some part, however small, of the material world, there are but few who have time to study their mental life, which indeed goes on none the better for being watched.

The elements of physical science are not only more necessary to life than knowledge of the mind—they are also more easily obtained. The facts of the material world are comparatively constant and accessible to observation. The stars return daily in their courses, and the plants repeat yearly their monotonous

lives. Inert matter may be observed and measured more readily than the living body; physics consequently preceded biology in its development. The changes of mental life are more fleeting and obscure than those of the body. It is natural, therefore, that, as biology is more backward than physics, so psychology should be more backward than biology. There was a time when all the sciences were nourished by philosophy. In Greece the philosopher and the man of science were identical, and those who most advanced mathematics and science in the revival of learning are called philosophers. With the increase of knowledge division of labor became necessary, and the separate sciences were defined. Those sciences were first developed which found data ready in the common knowledge of daily life, and which embraced subjects where experiment and measurement could be most readily used. The close relation in which psychology still stands to philosophy is thus explained by its comparative backwardness. This relation is not essentially different from that of the other sciences. Philosophy is not the arithmetical sum of the special sciences, but has a peculiar task. It seeks to investigate the conditions of knowledge, and to form a theory of the ultimate nature and meaning of things. Psychology is no more concerned with these matters than is physics. Experimental and mathematical physics need not and should not investigate the origin and ultimate nature of matter, nor should psychology as a natural science concern itself with the origin, destiny, and meaning of mind.

The subject-matter of psychology corresponds exactly to that of any other natural science. As physiology studies the phenomena of the living body, so psychology studies the phenomena of mind. It is often urged as an objection to psychology that the student can observe one mind only, but it is equally true that the student of physics can observe *with* one mind only. Were mental processes so irregular and idiosyncratic as is sometimes assumed, there would be no science of psychology, but physics would be equally out of the question. Psychology is not concerned with individual peculiarities, but with the laws to which all mental processes are subject. Its position is similar to that of physiology, which studies individual organisms in order to learn general truths concerning nutrition, movement, etc. The problems of psychology are evidently complicated by the fact that individual minds differ. But this difference is largely a matter of comparatively unimportant detail. The position of psychology is not very different from that of other sciences. Should astronomy seek to determine the orbits of all the satellites, of all the planets, of all the suns in the universe, it would have a hopeless task; but, if we understand one solar system, we have an astronomy to a large extent universal.

The methods of psychology are the same as those of other sciences. Science has its beginnings in common knowledge of daily life collected for practical ends. This knowledge is systematized, often in an artificial manner, and facts, often fancies, more remote from daily experience and usefulness are added. Attempts are made to simplify and explain, usually by arbitrary hypotheses. Thus it was thought by the early Greek physicists that the earth is explained by saying that it all consists of water or air or fire. Even in recent times it was thought an explanation to say that water rises in the pump because Nature abhors a vacuum, or that life is explained by the presence of a vital fluid. But as science advances it depends more and more on experiment and measurement. Data are seldom admitted which can not be verified by any competent observer, and mere matters of fact take a subordinate place. Exact science consists almost exclusively of measurements and the relations of quantities.

Psychology until very recently was in the position of science before experiment and measurement had been used. It consisted largely of useless descriptions, artificial classifications, and verbal explanations. A preference was given to matters which are extraordinary and unverifiable. But in the progress of science it has at last become possible to apply experiment and measurement to the mind. We have to-day laboratories of psychology where facts may be discovered, measurements made, and the results verified by every trained student.

To prevent misunderstanding, it may be worth while to notice what is not done in laboratories of psychology. They are not intended for the study of physiology. The functions of the nervous system may throw light on the workings of the mind, but the debt is reciprocal. We know, indeed, more concerning attention, memory, and thought than concerning the cerebral processes which may precede or accompany them. The commonly used term physiological psychology is awkward. There is a science of physiology and a science of psychology, and there are relations between body and mind. But these relations are wider than this —they are between matter and mind. Thus we know that vibrations of a special sort may be accompanied by a sensation which we call blue, but we know almost nothing concerning the corresponding processes in the eye and brain. The world is one world, and all science is interdependent, but the development of psychology has drawn a sharper line between mental and physical processes than was ever recognized before. The distinctions of material science are comparatively artificial, resting on our ignorance rather than on our knowledge. Whether bodies be as large as planets or as small as atoms is not a matter of great consequence. If we but knew the laws of matter in motion, they would

obtain equally in astronomy and chemistry. The phenomena of the living body must in the end be subject to the principles of physics, and physics must in the end become mechanics. But sensation, attention, and feeling can never be reduced to matter in motion. A complete correlation between mental and physical changes may be established, but the most perfect knowledge of the processes of the brain would of itself throw no light on the nature of thought. The blind man will not learn to see by studying the changes taking place in the combustion of a candle. Psychology can never be made a branch of physiology.

Laboratories of psychology are for the study of mental processes. It would not be possible in a single article to give an account of what has been accomplished by experimental psychology, nor would tables, curves, and mathematical formulæ prove interesting reading. "The plain man," in Bishop Berkeley's phrase, "undebauched by learning," is apt to ask, What is the good of all this? It may, therefore, be better to give several examples of the practical application of the results of experimental psychology. Pure science is not, indeed, an art whose end is to produce changes in the course of Nature. Astronomy is commonly regarded as the noblest of the sciences, but we can not alter the orbits of the planets, and the higher astronomy is not useful in the affairs of daily life. Science is an end in itself, as are the fine arts. It is good because it satisfies mental needs, and makes life better worth the while. But material science, while searching for truth, has not failed to contribute to the practical needs of society. Its applications in the arts and manufactures have guided the course of civilization. One man to-day can do the work which required ten men a hundred years ago, and the poor have now comforts and opportunities which were formerly not within the reach of the rich. In like manner we shall probably find that more exact knowledge of the mind will have many applications in pedagogy, in political science, in medicine, in the fine arts, and, indeed, in the whole conduct of life.

Let us consider pedagogy. Our methods of education have been greatly altered in the past few years, and more changes will follow. But we go forward blindly, not seeing the way, often retracing our steps. The poor children contribute to the progress of educational methods somewhat as the frog contributes to the progress of physiology. But we may hope to replace vague surmises with exact knowledge. In our laboratories of psychology we can test the senses and faculties of children. We can determine whether the course of study is developing or stunting fundamental characteristics, such as accuracy of perception, quickness of thought, memory, reasoning, etc. We can learn what methods best strengthen each of these faculties without injuring the others.

The overtasked teacher finds a child slow, and places it with more backward children, which increases its slowness. A more exact test of the child's mind may show that it is indeed slow, but that the slowness is more than counterbalanced by intensity and range. Methods must be applied which will shorten the time of thought, and will not interfere with its force and extent. We can determine what size and composition of class, what length of lesson, session, and term are most favorable. We can learn whether it is better for the student to do a thing, to see it, to hear it, or to read about it. We can never build a road to learning which need not be traveled by the student, but we can build a royal road in the sense that it is the shortest and best of roads. Above all, our tests and measurements will demonstrate the value of learning itself, and tell us whether under given circumstances it is secured by the development or sacrifice of more essential qualities, such as health of body, serenity of mind, common sense, honesty, and kindliness.

In laboratories of psychology not only children but every one can be tested, and small defects or changes in the senses and faculties can be discovered. Psychology may thus become an ally of medicine. Degenerations which escape common observation, and even the practiced eye of the physician, can be detected and measured by scientific methods. The overstrained clergyman or man of business can be told when a holiday is necessary, how long it must last, whether rest or amusement be required. As an example of the co-operation of psychology and medicine, surgery of the brain can be given. The part of the brain which is diseased is determined by psychophysical methods, the skull is opened, the diseased part of the brain is removed, and the patient may be cured. Psychological methods are useful not only in the diagnosis but also in the cure of many diseases. We know much better than formerly how the insane, the vicious, and the criminal should be treated. We know, for example, that social work is far better than solitary confinement. Even diseases not directly dependent on the nervous system may be cured by psychophysical methods—for example, suggesting to the patient in the hypnotic state that he will be cured.

Those in good health may also profit from an examination in a laboratory of psychology. Valuable traits can be determined as well as defects, and the profession and mode of life most suitable to the person can be indicated. As has been suggested by Mr. Galton, such tests would be peculiarly useful in civil-service examinations. They would determine the real qualities and fitness of the candidate in addition to (or in place of) the superficial knowledge temporarily acquired by "cram." While we have but little power to alter the individual character, we could exert

great influence on the future of the race. If we determine what traits are valuable, and how these can be developed by suitable marriage, and made universal by early marriage, we may hope for practical results of immense importance. By the development of a code of honor, or by direct encouragement of the parents or the State, degenerative tendencies could be eliminated, and valuable traits could be developed much more rapidly than occurs in the slow course of natural selection. Mr. Galton has shown that the offspring of early marriages will soon supplant the offspring of later marriages. But as things go at present the thoughtless and criminal are apt to have offspring early, while the reliant and mentally endowed postpone marriage until a long course of education is accomplished and a social position is secured.

It is not necessary to dwell on other applications of psychology. Its relation to the fine arts is evident. The external form of art is directly fitted to the senses and its inner essence to the mind. In political economy we need to know more concerning the interest, passions, and needs of the people. Ultimately, we shall be able to determine what distribution of labor, wealth, and power is the best. Indeed, the measurements and statistics of psychology, which at first sight may seem remote from common interests, may in the end become the most important factor in the progress of society. The whole course of life will move forward in straighter and broader channels when we no longer depend on instincts developed by the beast and savage, but on knowledge and reason guiding to an end.

DR. BAUMANN, in his recent journey in countries north of Lake Tanganyika, discovered the source of the Kagera or Ruvuvu River in about latitude 3° south, in a lofty range of mountains known as the Mountains of the Moon. The Warundi—whose ancient kings bore the title of Mwezi (Moon), and who looked upon Dr. Baumann as one of their descendants just returned from the moon, and consequently received him with noisy demonstrations expressive of their joy—look upon this spot as sacred. Within a wood close by they used to celebrate the funeral rites of their kings, whom they buried on the top of a mountain rising above the Mountains of the Moon.

DR. D. G. BRINTON has made a study of the Song of the Arval Brethren, a priestly sodality of ancient Rome, of presumed Etruscan origin, which was sung at their annual festival, and has found in it the name of a divinity which is also a divine name among the Libyan tribes of northern Africa, and is perhaps the root of the name of those (the Berber) tribes. This hint of connection between the Etruscans and these peoples is supported by the discovery of the name of "a man of the Tursha" at Gurob, near the Libyan boundary of Egypt, and of an Etruscan ritual book in the same region. The stem Adur, equivalent with that of Tur in Tursha, and with Etrur in Etruria, occurs also in the name Adurmachides—the fighting Adurs—given by Herodotus to a tribe living in the same region."

A CHARACTERISTIC SOUTHWESTERN PLANT GROUP.

By HENRY L. CLARKE.

A CURIOUS fascination gathers round any type of plant life that stands alone, as peculiarly characteristic of some one region of the world; and still greater does the interest become when we find, instead of a single type, an extensive group of closely related types holding a thus isolated position, and constituting a flora of themselves apart from surrounding plant realms. But such instances are rare—their very fewness primarily accounts for the impression they make upon both scientist and general

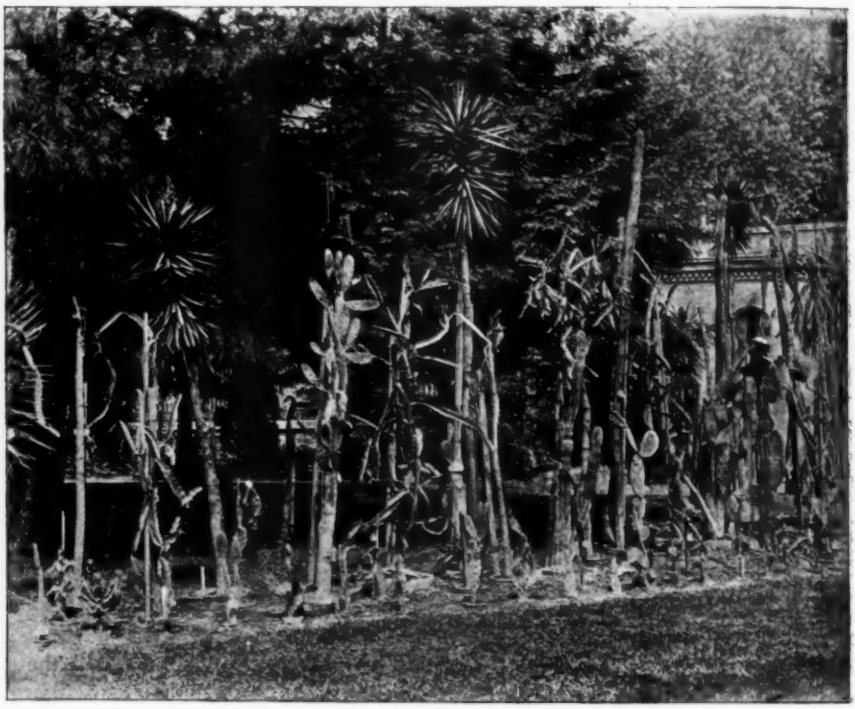

Fig. 1.—Opuntia, Cereus, and Yuccas.

observer. In one corner or another of every continent botanists have found oddly specialized floras, distinct in aspect and purpose from the general run of vegetable forms. Many of these cases are of insignificant importance, save in their immediate interest to the specialist; some attract greater attention, as filling an especially noticeable gap in the series of plant relationships; a few become of widespread interest not only through unique specialization of structure, but also by virtue of their holding a really

extensive and vitally important place in the economy of Nature. Of these last few one instance rises up most prominently of all, certainly without a full parallel elsewhere in the field of botanical science—and do we realize that it stands almost at our doors? It is the great three-typed plant group that forms the major part of

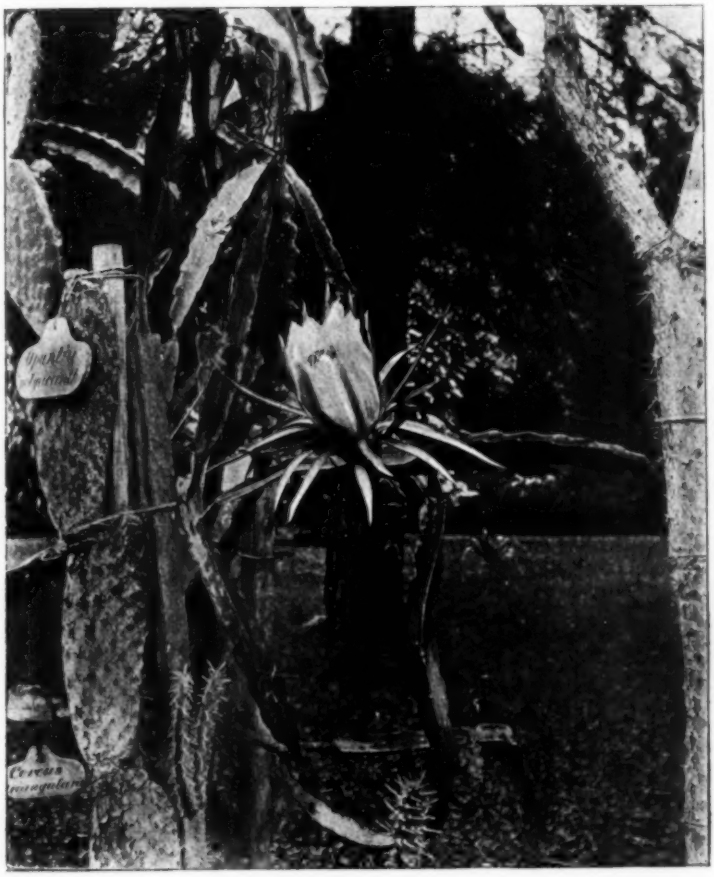

FIG. 2.—CEREUS TRIANGULARIS.

the flora of the far Southwest, on the arid plateaus and plains and rocky mountain heights of Arizona and New Mexico, western Texas and southernmost California, and over the boundary line far into northern Mexico. Here is the fatherland and here the supreme province of those three marvels of plant life—the cacti, with their strangely specialized vegetative body; the agaves, to which popular tradition has attached an epithet of fitting dignity in the name of "century plants"; and, thirdly, the yuccas, which claim, in addition to their floral splendor, the distinction of manifesting the interdependence of the flower and insect worlds with

probably more striking force than obtains in any other single instance throughout the range of flowering plants.

Only within the memory of men still in the prime of life has the full significance of this Southwestern flora dawned upon the world of science. Far back in the history of early explorations travelers and naturalists had recognized the odd character of these north-Mexican plant forms, but to realize their inward meaning required the elaborate monographing of Engelmann and the broad generalizing of Asa Gray. For, strange as it may seem, one investigator after another, enthusiastic over the rich flora spread in such profusion from our Atlantic seaboard westward beyond the Rockies, nevertheless shunned, because of the many difficulties presented, this threefold group of Southwestern vegetation. Yet this, above all else, was a flora peculiarly American—originating, so far as we have yet been able to discover, on American soil, and belonging to America alone. So here there was a prospect of opening up to science a new aspect of plant life, and in due season the men came with the opportunities and inclination to accomplish the task. Foremost of all, and more than all the rest, stood forth the St. Louis physician, Dr. George Engelmann, a skilled man of medicine, with botanical inspiration. In him there seemed to be an especially keen appreciation of the opportunity offered for vastly aiding the cause of botanical science by the systematic study of little-known groups of plants; and through labors of this nature, in addition to his note as a physician, he placed his name among the greatest of monographers in the annals of botany. And to him belongs the credit of turning the full light of science upon the cacti, the agaves, and the yuccas, while through his investigations of these types the attention of our great American systematist, Asa Gray, was first directly turned to the vegetation of the Southwestern highlands. One of the absorbing problems of Gray's life-work was what he once fitly termed "botanical archæology"—the study of the geographical sources of our wealth of flora, and of the paths by which it had passed from one region to another. Years of experience had enabled him to propound the masterly theory of the great wave of ancient plant life sweeping down from the north and giving to the Old World and the New floras that have so many types in common. But later, largely in the light of Engelmann's revelations, Gray was brought to fully realize that a second great source of the peculiar elements in our flora lay in the Southwest, down on to the Mexican plateau, and beyond the reach of the influence of the Glacial age. Here was the possible source of a vegetation strictly American, and to it might be traced many now widely scattered tribes, but particularly and most obviously the three unique types we are especially considering. These have come down to us, in the land of the

Aztec, as the descendants of an American flora whose traces are lost in far-off geologic ages, even as the forefathers of the Aztec are shrouded in the mist of prehistoric centuries. In truth, there seems a striking fitness in associating these odd monarchs of the soil with the barbaric majesty of the empire of Montezuma; a John Ruskin might say, the cactus typified the Aztec's sturdy, unwithering energy and stoic cruelty; the agave, his lofty nobleness of mind; and the yucca, the passionate beauty of his nature. But let the sentiment stand—the Aztec has passed away, and yet

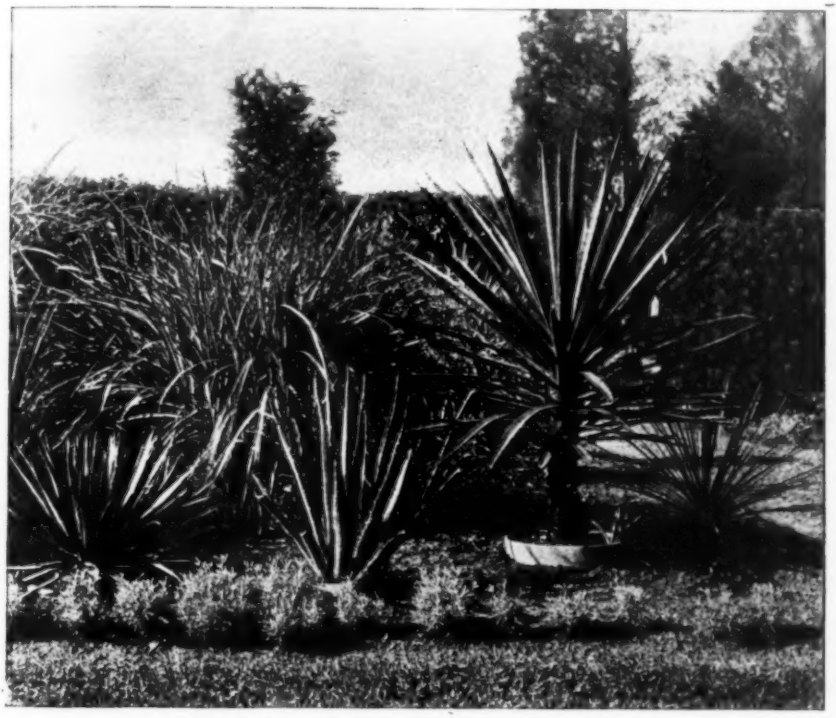

FIG. 3.—AGAVE BED. Tree Agave on the Right.

this plant group still holds its own over the rocky hills and mountain sides and barren plateaus, withstanding drought and burning sun, and thriving in the arid sand wastes. And out from their native region many representatives have found their way southward, over into the West Indies, down through Central America, still further to the northern Andes, and almost to the Amazon; and others, though fewer, have come up into our Western plains and mountains, scattered over the Mississippi Valley, and passed through the Gulf States and far up the Atlantic coast. Thus eastward and northward from Texas we can count perhaps a dozen cacti, several yuccas, and one or two agaves, all luxuriating

in their adopted habitats. Such, then, is a general suggestion of the position this plant group holds in our American flora. Let us now outline the relations of its three members to each other and to other flowering plants in general.

It is worthy of note that the three types referred to bear no close relationship to one another; on the contrary, they stand in distinct and rather parallel classes, and each respectively among the most perfect developments of its class. The cacti, on the one

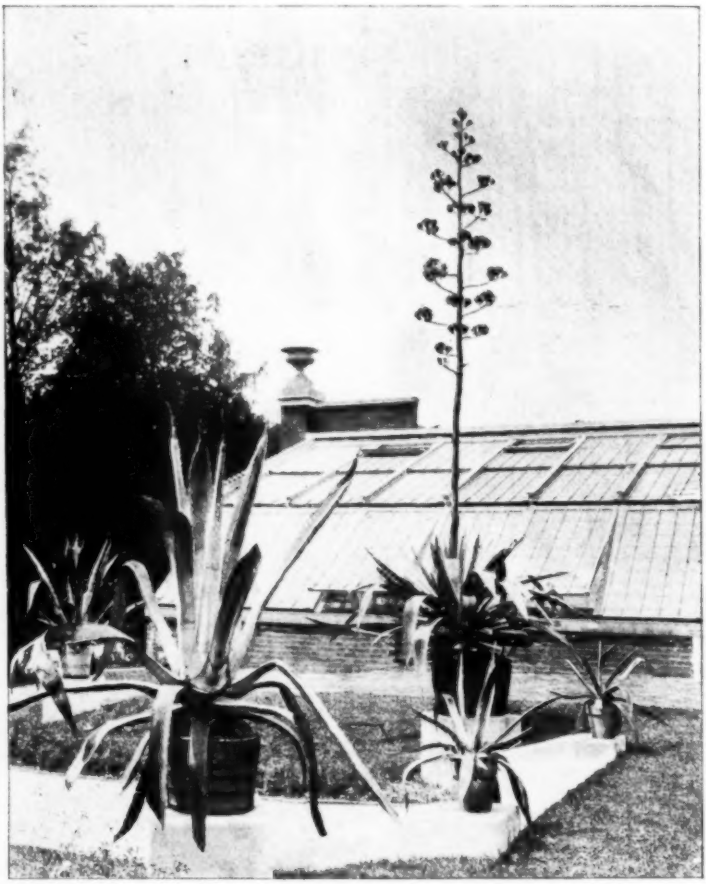

FIG. 4.—AGAVE SALMIANA IN BLOSSOM, AND AGAVE AMERICANA IN FOREGROUND.

hand, hold a place among the most highly organized of dicotyledons; while the agaves and yuccas belong in the other great class of angiospermous flowering plants, nearly parallel, but lower ranked—the monocotyledons. Further, the agaves and yuccas stand in nearly parallel divisions among monocotyledons—the agaves among the epigynous-flowered monocotyls, typified by the amaryllis family; the yuccas among the hypogynous-flowered

congeners of the lily family. Both, moreover, are highly specialized representatives of their respective alliances, and of the two the agaves represent the higher character of development. Thus augmented interest is joined to all three when an outline of their position in the vegetable kingdom shows us that they are to be regarded as almost, if not quite, the highest products of the evolution of that ancient Aztec-American flora whose descendants they are.

And so we are brought to realize that they were worthy recipients of all the attention Engelmann and his co-workers bestowed; and the history of their investigations becomes almost as interesting as the plants themselves. Foremost of all, as has been said, stand the labors of Engelmann; but with him are associated the names of many untiring explorers and enthusiastic botanists, each of whom contributed some vital element to the general outcome: Wislizenus, Emory, Torrey, Parry, Schott, Palmer, Newberry—all were workers in the field, and their names have gone down in the annals of botany appended to one species or another of the genera they studied, fittingly commemorating the aid they gave toward awakening scientific interest in this Southwestern plant group. Engelmann gathered together the work of all and compiled it in his masterly monographs, taking up first the cacti, then the yuccas, and finally the agaves. From time to time he published additional notes, as new store of information came to him, presenting most of the matter to the St. Louis Academy of Sciences, of which he was for years the leading support. Up to the month he died he was working over the great mass of notes he had accumulated on the cacti, preparatory to publishing a grand revision of his first monograph. That the work could not be completed is a source of deepest regret to living botanists; but, nevertheless, the original monograph still stands, and will continue to stand, as the backbone of our knowledge of the family it treats. And as to the other two monographs, the past decade has been able to add little to them of vital importance save in so far as more extended observations have served to more fully develop Engelmann's views. With justice, therefore, is Engelmann accorded a prominent place among scientists; but inseparably linked with his is the name of another man, honored as a broad-spirited patron of science, Henry Shaw, the founder of the Missouri Botanical Garden, on the outskirts of St. Louis. This was the pride of Engelmann's heart, and it was here that he constantly labored under the liberal patronage and never-failing encouragement of Shaw. The two men worked and planned together in their common interest, and as a result we find in the Missouri Garden tô-day species of cacti numbering in the hundreds, of agaves more than half a hundred, and the better

FIG. 5.—AGAVE ENGELMANNI.*

* Figs. 5, 6, 10, 11, and 12 are from the Report of the Missouri Botanical Garden for 1892, and Fig. 8 is from the same report for 1893.

part of all the known yuccas, altogether forming one of the most complete collections in the world of these Southwestern types; and he who carefully examines it will be ready to acknowledge it one of the most fascinating of all plant collections. Surely it could have no more fitting home than there in the city of Engelmann; and we can not but cherish the hope that no pains will be spared to make the collection even far more complete than it is, and thus give the American botanist a still greater laboratory in which to investigate so great a factor in American plant life. A suggestion of this aspect of the Missouri Garden may be found in the illustrations accompanying the present paper, most of which are from photographs taken there in July, 1892. The magnificent collection of cacti and the several flowering plants of agave in the World's Fair are of the highest interest in this connection. Can not these form a nucleus for a great permanent cactus garden?

From the general discussion we may appropriately pass to a more detailed sketch of each of the three groups before us, and in taking them up it will be found most convenient to place them in the order of their evolutionary rank: the cacti first, as representing the higher class of flowering plants; then the agaves; and lastly the yuccas, as somewhat lower in station than the second. This will have the merit, in addition to its logical virtue, of disposing of the weightiest group first, and of leaving till the last an amazing little entomological-botanical romance which gathers round the yucca. And the stately agaves will be not inharmoniously sandwiched between their two odd brethren. But let this suffice for a prospectus; the story will tell itself more satisfactorily.

Viewing the three members of our group together, the query presents itself: Is there not some vital significance in the relative extent and diversity of development in these three joint monarchs of the desert? Two of them, those we shall consider later, reach only the magnitude of genera, each constituting a moderate-sized and not remarkably diversified genus; while on the other hand the cacti together form an immense family, the natural order *Cactaceæ*, aggregating over a thousand species, gathered into a number of genera. It is but a grand example of evolutionary principles, "natural selection and the survival of the fittest," for the facts must be interpreted in the light of Darwin's immortal phrase. The yucca pushes its sturdy rootstock through the sand and drinks up each available drop of water; the agave's succulent leaves store up a wealth of nutritious sap; but the cactus seems to be pre-eminently an invulnerable storehouse of life-giving moisture, and the veritable offspring of the arid, rocky sand-wastes, while the others seem only adopted children. Mark the peculiar characters of the typical cactus: The

compact mass of the vegetative body, devoid of leaves or leaf-like appendages, exposes the least possible evaporating surface to the sun; the thick skin, bearing only a few scattered stomata, breathing pores, wraps an almost impermeable covering round the internal moisture; the long, wiry, fibrous roots run hither and thither through the sand and into the finest crevices of rocks; and further, the bristling, spiny armor shields the plant from men and beasts. All this and much more goes to make up the plant of plants that is best fitted to fulfill the mission of vegetation in the Southwestern borderlands. And so the problem solves itself, and we come to realize why the progenitors of the *Cactaceæ* spread out and multiplied far and wide, and broke into a myriad varied forms, all retaining amid their diversity the distinctive characteristics of the primal type.

A standard British encyclopædia of scarcely three quarters of a century ago vouchsafes the statement that the order *Cactaceæ* embraces "twenty-seven" species. Grasp the contrast between this day of science and that! The botanists of the Century Dictionary estimate the species at far above the thousand mark. For this vast stride we thank a host of indefatigable explorers, and of these, a large share of credit goes to the scientists of the Mexican Boundary and the Pacific Railway Surveys, whose discoveries were the main foundations of the labors of Engelmann. Thus duly recognizing the scope of the field before us, we may with interest follow an outline sketch of the order. The general character of the vegetative body may be passed over for the present without further detail, that we may the more particularly notice the floral structure on which the systematic study of the order so largely depends. The inferior ovary, surmounted by the sepals, petals, and stamens, places the order immediately among the highest of the dicotyledonous *Choripetalæ*. There is a natural division into two suborders. In the first, the *Rotatæ*, the rotate many-leaved calyx and corolla, with the stamens, directly surmount the ovary. In the second there is a unique and obviously progressive development: calyx and corolla are united toward their bases and prolonged into a tube, with the stamens inserted on its throat—whence the name of the suborder, the *Tubulosæ*. The typical *Rotatæ* are the widespread genus *Opuntia*, numbering about two hundred and fifty species. The greater part of the genus are characterized by broad, thickened, fleshy, jointed stems; but a small subgenus, and this probably the less highly specialized, have cylindrical joints. Most of the species are more or less spreading and prostrate, but a large number are truly arborescent in growth. Several species are thoroughly naturalized in the northeastern quarter of the United States, and these are among the most brilliant acquisitions of our

Northern flora. The gorgeous yellow of *Opuntia Rafinesquii* and *O. Missouriensis,* flourishing on a sandy hillside beneath the July sun, can well inspire the soul of botanist and flower-

FIG. 6.—YUCCA GLORIOSA.

lover. It is an interesting and significant fact that among the *Rotatæ*, as allies of the *Opuntia,* we find the two little genera that

nearest approach being missing links between other neighboring orders and the *Cactaceæ*, otherwise almost utterly isolated. One is the genus *Pereskia*, in which, especially in *Pereskia grandifolia*, there are developed true leaves, succulent and veiny and with spines in their axils. Most species of the genus are shrubs or trees, and, still further remarkable, the flowers are borne in nearly panicled clusters. The thirteen species belong mostly to the West India region, and one produces the so-called "Barbados gooseberry." A decided analogy may be recognized by close comparison between these *Pereskias* and the *Ribeseaceæ*, the group of the saxifrage family which includes the currants and spiny-stemmed gooseberries; and this probably points to a distant connection between the progenitors of the *Cactaceæ* and those of the modern genus *Ribes*. The other possible "missing link" is the genus *Rhipsalis*, a curious group, mostly epiphytic, and growing in long, pendent masses from the branches of trees, in some instances resembling mistletoe. In these plants we see a possible approach to the group of so-called "ice-plants," the order *Mesembryanthemaceæ*. But most peculiar is the fact that one species of *Rhipsalis* is indigenous to South Africa, Madagascar, and Ceylon—the only instance of an Old World cactus. This probably has its significance.

The other suborder, the *Tubulosæ*, are undoubtedly the more highly specialized cacti, and further, significant fact, they are for the most part Mexican, while the *Opuntiæ* are widely scattered northward. Besides several minor genera of *Tubulosæ* there are three great and distinctive ones, which, as it is interesting to note, mark successive steps in structural specialization—they are *Mamillaria*, *Echinocactus*, and *Cereus*. In mamillaria there is a great departure, in the character of the vegetative body, from the *Opuntiæ*. The plants are more or less globular or subcylindrical, and the original joints of the stem are indicated only by the conical spine-tipped tubercles which make up the surface of the fleshy mass. Echinocactus, the "hedgehog cacti," has the general appearance of mamillaria, but the tubercled surface is modified into a mere series of parallel vertical ribs, bearing clusters of spines along their ridges at points corresponding to the tubercles of mamillaria. Of the two genera, echinocactus is much the more strictly Mexican, while mamillaria has a few representatives spreading northeastward into Kansas and South Dakota. The large genus *Cereus* is the crowning glory of the cacti. It retains the ribbed structure of echinocactus, but its stems are nearly always columnar and in many instances arborescent. With echinocactus, this genus reaches its greatest development in Mexico, or near the boundary line, where flourishes the monarch of the *Cactaceæ*, the "giant cactus," *Cereus giganteus*. In cereus,

furthermore, is the fullest development of the tubular floral structure, much less evident in echinocactus and mamillaria. Thus we find the cacti forming a little kingdom of their own, and could we here go beyond the limits of an outline, a broadly interesting study might be found in each division of the order. But without further detail the vitally important observation may be made, that there seems just reason to believe that what the *Compositæ* are to modern plant life in general, the *Cactaceæ* were, and

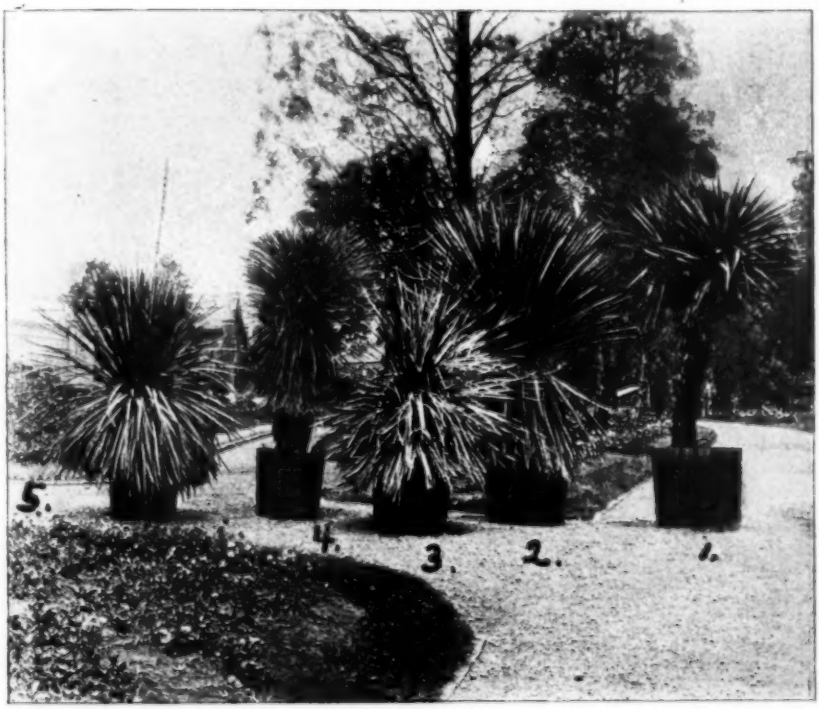

FIG. 7.—YUCCA GROUP: 1, Yucca macrocarpa; 2, Yucca treculeara; 4, Yucca elata; 3 and 5, Yucca dasylirion.

probably are, to that ancient Southwestern flora—the climax of its evolution.

Linnæus vividly expressed the spirit of the "century plant" in one Greek word, the very name he gave it—"*Agave*," so called, he said, "because that word indicates something grand and deserving admiration"; and although he only knew a half-dozen species, the many that subsequent research has brought to light justify most fully the title he bestowed. The genus holds a station of its own in the foremost ranks of monocotyledons, but, like the cacti among dicotyledons, rather isolated. It certainly approaches the amaryllis family in many characteristics, and, if really coming within the limits of this order at all, may perhaps

be considered a highly specialized offshoot. There is immense variation in the foliage characters of agave, from the slender

FIG. 8.—YUCCA GUATEMALENSIS.

reed-like leaves of *Agave geminifolia* to the massive blades of *Agave Americana*. The character of the inflorescence has been

made the basis for the primary division of the genus into three groups: the *Singuliflorœ*, the *Geminiflorœ*, and the *Paniculatœ*. In all cases the flower-scape rises from the apex of the main axis of the plant; all the vital energy of often many years' growth is centered there, and the plant throws up its blossom-stalk as the supreme effort of its existence, and, when the fruit has ripened, dies —a strange phenomenon, and almost without parallel in any other so extensive group. In the *Singuliflorœ* is the simplest type of inflorescence. The flowers are loosely spiked, each one in the axil of a bract. To this group belongs our one Northern agave, the little *Agave Virginica*, which grows from Maryland and southern Indiana southwestward into Texas. The *Geminiflorœ* have the flowers borne in pairs, and densely spiked along the scape. Variations which show transition between both these simpler groups and the third occur. The *Paniculatœ* have the scape more or less branching, often in the fashion of a candelabrum, each branch terminating in a dense cluster of flowers. These are the typical agaves, the crowning glory of the genus. The familiar *Agave Americana* is a representative of the *Paniculatœ*, and so also the plant shown in the accompanying photograph (Fig. 7), *Agave Salmiana*, a magnificent species that blossomed in the Missouri Botanical Garden in the summer of 1892. A splendid agave that commemorates the founder of the Missouri Garden is the *Agave Shawii*, dedicated by Engelmann to Henry Shaw; and in turn the labors of Engelmann have been fitly honored in the dedication to him of a most striking type that he once presented to the Missouri Garden. It blossomed there in the summer of 1891, and when it had been clearly proved a new species it was duly christened by Director Trelease *Agave Engelmanni* (Fig. 5). The structure of the agave flower is extremely unique in several particulars, but further detail can not be entered into. Almost every step taken in the investigation of the genus gives additional emphasis to the first impression, that it is one of the master marvels of plant life.

It remains to add some passing notes on the wonderfully beautiful genus which the lily family contributes to our group, the yuccas. A glorious floral offering to the arid Southwest highlands they certainly are, and scientifically their structure is in many ways scarcely less remarkable than that of the cacti and agaves. But the consideration of these points will be passed over here in order to call up more particularly the phenomenon that makes the yucca an astounding mystery to naturalist and philosopher, the manner of its cross-fertilization. For the fact is, we have here an extensive genus entirely incapable, save under most rarely extraordinary circumstances, of self-fertilization, and entirely dependent on one moth that fertilizes the flowers in order to insure food supply for its larvæ in the ripening seeds. The problem of

yucca fertilization was for many years a vexed question; Engelmann spent much thought and observation in trying to learn its secret, and finally, over twenty years ago, called the attention of Prof. C. V. Riley, the noted entomologist, to certain moths which frequented the yucca flowers. After long and patient study and various erroneous speculations the two scientists ultimately brought the whole mystery to light; and in a recent paper, published in the Report of the Missouri Garden for 1892, Riley has fully elaborated his work of the earlier years and the observations made in the intervening time. The structure of the yucca flower

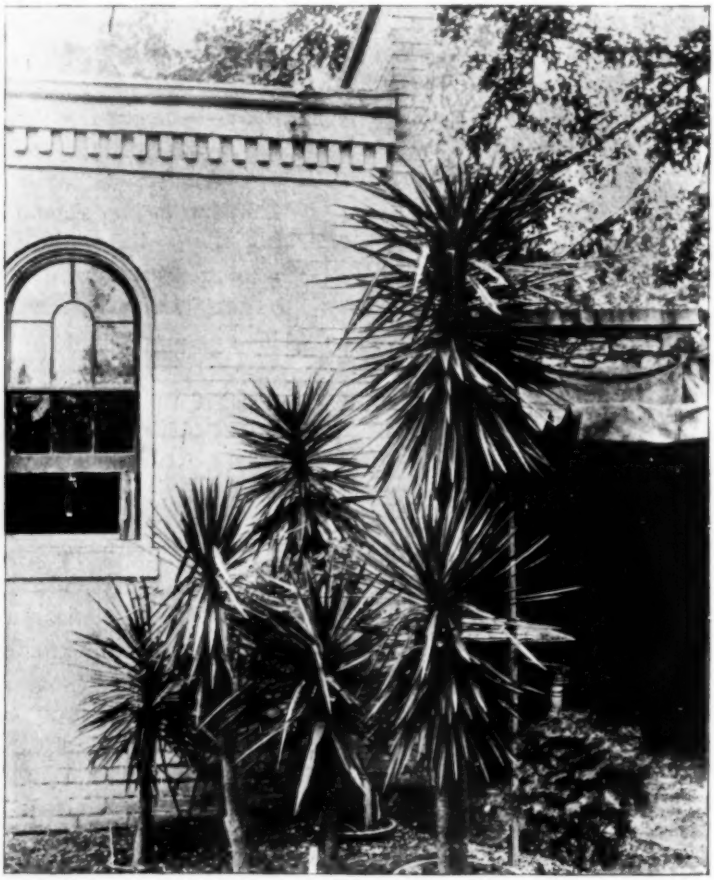

FIG. 9.—YUCCA ALOIFOLIA.

is plainly outlined in Fig. 10. Long experimentation has positively shown that it is practically impossible for the sticky pollen to be transferred from the little anthers on the tips of the short stamens to the fine stigmatic tube opening only at the tip of the pistil, except by external voluntary agency. As a matter of fact, the agency is

always the little moths of the genus *Pronuba*—never any other insect whatsoever. Several different species of *Pronuba* frequent respectively several different species or groups of species of yuccas,* but the most familiar one is the *Pronuba yuccasella*, always found on our *Yucca filamentosa*, the most Northeastern type. Just about

FIG. 10.—FLOWER OF YUCCA GLORIOSA.

nightfall, as the flowers open, the moths are seen flitting about the yucca panicles. Usually the male is most constantly on the wing, while the female is found running about within the flowers. She begins operations by mounting the top of a stamen, exactly as shown in Fig. 11. There she scrapes with her two odd hook-like maxillary palpi the pollen out of the anther, and rolls it into a globular mass under her head. With this load, often thrice the size of her head, she goes to another flower, runs about, apparently examines every nook and corner of it, and then, if perchance satisfied, finally settles astride two of the stamens with her

* In the Report for 1893 of the Missouri Botanical Garden, Prof. William Trelease, Director of the Garden, publishes a paper on yuccas, from which the following notes are made with reference to the *Pronubas* frequenting different species of the plant: *Pronuba yuccasella* pollinates *Y. filamentosa*, *Y. aloifolia*, *Y. glauca*, *Y. baccata*, *Y. gloriosa*, *Y. elata*, *Y. glauca*, var. *stricta*; *Pronuba synthetica* pollinates *Y. brevifolia*; *Pronuba maculata*, *Y. Whipplei*; and *Pronuba maculata*, var. *aterrima* (a new variety of *Pronuba* discovered by Prof. Trelease in 1892), pollinates *Y. Whipplei*, var. *graminifolia*; and, finally, Prof. Riley predicts the discovery of distinct species of *Pronuba* on each of these yuccas, viz.: *Y filifera*, *Y. treculeara*, *Y. Guatemalensis*, and others.—H. L. C.

abdomen pressed down between them. From the tip of the abdomen the long, sharp-edged ovipositor, an organ of wonderful delicacy and most remarkable structure, is thrust into the tissue of the pistil, and the eggs are deposited among the ovules. This act may occur several times on the same pistil. Then, still more remarkable, the moth deliberately runs to the apex of the pistil and with tongue and palpi crams a portion of the collected pollen mass into the stigmatic tube, thereby fertilizing the flower. The tongue is worked up and down for some time in the tube like a piston rod, with evident intentness on the part of the moth. This

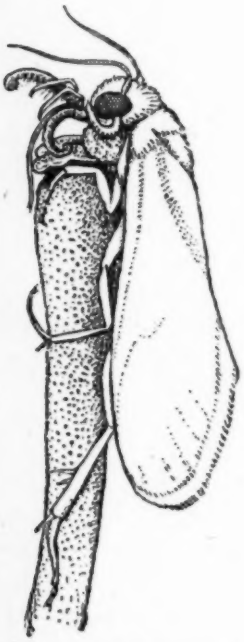

FIG. 11.—PRONUBA YUCCASELLA.

FIG. 12.—FRUIT OF YUCCA GLORIOSA.

series of operations, always in the same order, may be repeated again and again till late into the evening. The moth chooses only the freshly opened flowers and those that have not been punctured by another moth coming before. Only the flowers thus fertilized can ever by any possibility produce fruit; and thus the yucca fruit, as seen in Fig. 12, always bears several constrictions where the scar was made by the puncture of the moth's ovipositor. Inside the fruit the moth-larva develops with the seeds, devouring sometimes a dozen of them; and when the pod ripens the larva eats its way out, and, in the night-time, drops to the ground by a silken thread, burrows into the soil, and there wraps itself in a strong cocoon. Sometimes the moth does not issue

from the cocoon for several years, though not so generally. It is strangely true, however, that moth and yucca flower mature at the selfsame season; and strangest of all, it can not be shown that the moth during its short existence in the perfect state takes a particle of nutriment from the yucca flower—no pollen, no nectar, no stigmatic fluid. This is practically certain. Here, then, is a case of "instinct" that is utterly dazzling; it bids defiance to comparative psychology, philosophy, metaphysics—everything. Here is a plant that can not perpetuate itself without one certain strangely specialized moth; and here is a moth that can not live without that plant; and that moth deliberately cross-fertilizes the flowers without receiving any nutriment from them! Verily, the botanist must rise up and say of the yucca moth what Cicero said of the aged planter of orchards, "Serit arbores quæ alteri sæclo prosint!" and even with greater truth. This is interdependence between the worlds of insect and plant life that baffles understanding.

Cacti, agaves, yuccas, such is the three-typed group that stands out as a great division of a flora distinctively American; unique in the phase of plant development it presents; peculiar to a region of strange physical aspect; sprung directly, for aught that is known otherwise, from the mystery-shrouded soil of the Aztec and the cliff-dweller. And this is the splendid tribute the land of the far Southwest gives to the world of science.

HOUSEHOLD ARTS AT THE WORLD'S FAIR.

By FREDERIK A. FERNALD.

THE visitor who wishes to learn what the World's Columbian Exposition has to teach in regard to the domestic arts will not find the exhibits in this field gathered in a separate building, as are those relating to Transportation or Agriculture. He will not find them entered as one class in the Official Catalogue, but must search them out in nooks and corners, and will often stumble upon them in the most unlikely places.

To begin with the house itself: two specimen dwellings of low cost are exhibited. Away down near the southeastern corner of the grounds is a neat wooden cottage, forming part of the New York exhibit, and known as the Workingman's Model Home. The house, with cellar, would cost ordinarily $1,000; it measures 20×28 feet, and is designed to stand on a lot of 25×40 feet. On the first floor are a hallway, living room, kitchen, bath room, and storeroom; on the second floor are three bedrooms, each with a closet, and a large closet at the front end of the upper hall. The

house is furnished, and clothing for a family consisting of a man, wife, and three children is hung in the closets. Posted in the several rooms are lists giving the cost of the furniture, the clothing, and the living expenses. The outfit of furniture amounts to $300. The yearly expenses are estimated at $500, apportioned as follows: Rent, $120; food, $200; clothing, $100; fuel, $30; miscellaneous, $50. Experiments in feeding a family of five are carried on in the house by Miss Katherine B. Davis, of Rochester, and the bill of fare for each day since the beginning is posted in the living room. The cost of food for the whole family has ranged between fifty and sixty cents a day.

Just inside the Midway Plaisance stands the Philadelphia Workingman's House. It is a two-story structure of brick, the dimensions being 15×43 feet, and it was erected by the Social and Economic Science Committee of the Woman's Auxiliary of Philadelphia. It contains six rooms and a bath room, has a furnace, and the cellar is concreted. Such a house could be built in most places for $2,300. Floor plans of both this and the New York house can be had for a small charge.

The several exhibits of cooking processes and appliances would make a very creditable display if brought together in one building. Opening from the gallery of the Woman's Building is a large room, where a lecture on cooking is given daily, after which the lecturer spends several hours in answering the questions of interested listeners. This room is called a Model Kitchen in the Official Catalogue, but it is fitted up as a lecture room, and not as a kitchen. The National Columbian Household Economic Association, organized by the Committee on Household Economics of the Board of Lady Managers, provides a lecturer, Mrs. Emma P. Ewing, for two months of the season that the fair is open. She lectured on bread-making during June, and is to return for the month of October. During the whole six months Mrs. Sarah T. Rorer lectures under the auspices of the Illinois Woman's Exposition Board. The board has assigned to her the special task of making known the proper way of cooking corn products to American and foreign visitors, with the object of widening the too restricted market for this product of our soil. Accordingly, Mrs. Rorer describes only dishes into which corn enters in some form. Her list is far from being so narrowly restricted as many might suppose; she has over two hundred recipes available, including breads, puddings of cornmeal and cornstarch, griddle cakes, mushes, hominy, blanc mange, and (not to be omitted) Philadelphia scrapple. A selection of these is included in the little recipe book given away at the lectures. Mrs. Rorer also gives lessons to a class of girls, the purpose of which is to show how cheaply instruction in cooking may be introduced into public schools.

Returning now to the southeastern corner of the grounds, we find close to the Anthropological Building a small structure devoted to demonstrations in cookery. Owing to various obstacles it was not opened until about August 1st. These demonstrations form part of the Massachusetts exhibit. They are conducted by Miss Maria Daniell, under the general direction of Mrs. Ellen H. Richards, Instructor in Sanitary Chemistry at the Massachusetts Institute of Technology. The building is called the Rumford Kitchen, after the scientist of Massachusetts birth who did so much to advance the art of cooking just a century ago. Selections from three classes of dishes are prepared and served; namely, soups, luncheons for school children and students, and foods for the sick. Leaflets containing instructive matter are distributed, but no set lectures are given.

Beside the Rumford Kitchen stands another small building, also devoted to the teaching of cookery, and opened about the same time as its neighbor. This is a part of the New York exhibit, and is in charge of Miss Juliet Corson, the head of the New York Cooking School.

Considerable evidence may be found that cooking is being made a subject of school instruction in this and other countries. In the educational exhibits of the several States, which are placed in the gallery of the building of Manufactures and Liberal Arts, this subject is included in the school programmes of many cities and towns, and some pictures of classes at work are shown. From the gentleman in attendance at the educational exhibit of Japan the writer learned that domestic economy is taught in the schools of that country. In the German section of the Woman's Building is an alcove containing utensils, charts, and models of buildings used by the people's kitchen schools, household schools, and homes and schools for servants in Germany, with statistics concerning these and related institutions. This exhibit was prepared by Frau Lina Morgenstern, of Berlin. Near by may be found information concerning the housekeeping and other schools maintained by the Ladies' Societies of Baden, with pictures of the schoolrooms.

When we look to see what articles of home cookery have been sent for exhibition we find that the catalogue of the Woman's Building mentions fig preserves, other preserves, jams, jellies, home-made wines, and catsups, sent by four exhibitors, as being in the lecture room, but a diligent search in that room fails to reveal them. In the exhibit of woman's work in the Illinois Building, made under the management of the Illinois Woman's Exposition Board, is a neat case in which the Chicago Exchange for Woman's Work exhibits preserves, jams, jellies, and several kinds of pickles, very attractively put up. Preserves and jellies put up by women may also be found in the North Carolina section of

the Agricultural Building and in the Florida and Colorado sections of the Horticultural Building. In the latter building also is a large and varied assortment of apple jellies, each kind bearing the name of the variety of apple from which it was made, exhibited by a Maine woman. Across the avenue, outside the fair grounds, is the interesting exhibit of Manitoba. Here may be seen a large collection of preserved fruits and preserved and pickled vegetables, all put up by women in their homes.

The food stuffs, and especially the partly prepared foods exhibited by manufacturers, are numerous and varied. Most of these are placed in the gallery of the Agricultural Building, but there are a few important exceptions. Butter and cheese are to be found in the Dairy Building, coffee and tea in the foreign buildings or foreign sections of the large buildings. A great part of the exhibit in the Brazil Building consists of coffee, and this product is shown also by other countries of South and Central America and the West Indies. In some of the buildings a cup of the beverage may be had. Ceylon tea is served by Cingalese attendants in the Ceylon Court and in three or four of the general buildings. Four of the prominent chocolate manufacturers have separate small buildings in various parts of the grounds, and another has an attractive exhibit in the Agricultural Building. At all of these chocolate and cocoa are served. In the main food display the great packing houses exhibit canned, smoked, dried, and salt meats, canned fish and shell fish, mince-meat, lard, extract of beef, and canned soups. An English firm has gone one step beyond the canned soups and sends desiccated soups. Butterine or oleomargarine is shown by several manufacturers, and accompanied by clear and frank statements of how it is made and what it may be used for. Mixtures of beef suet and cotton-seed oil, under the names of vegetole, cotosuet, and cottolene, are offered to take the place of lard. The value of rice and rice flour as food is well shown in the Louisiana section of the Agricultural Building. Brands of salt which are declared to withstand the attacks of "General Humidity" are exhibited in this building and in the Mining Building. In the inventions room of the Woman's Building are evaporated vegetables and sweet-potato flour prepared by a process which was invented by a St. Louis woman. Condensed milk and evaporated cream, baking powders, gelatin, fruit butters, pickles, and catsups are among the many other foods shown by enterprising manufacturers. At many of the food booths visitors are invited to taste the foods, and are requested to register their own names or those of their grocers.

There is no lack of appliances and utensils for cooking. The ranges are too numerous to mention, but a few unusual features may be noticed. One make has a round iron plate on the floor of

the oven which revolves easily when it is desired to turn a pan that is set upon it. Another has a round piece cut out of the upper side of each cover and held in place by screws, its object being to prevent cracking. Still another has one cover made up of concentric rings so as to furnish five different-sized holes. Mrs. Rorer exhibits at her lectures a range having a perforated oven door lined with wire gauze. This, she says, enables meats to be really roasted in an oven instead of being baked. A range with which is combined a hot-water house-heating apparatus, the invention of a Chicago woman, is also shown in the lecture room and in the Manufactures Building. A long line of cooking apparatus for gas is shown, at one end of which is a simple hot plate and at the other a range with baking oven, broiling oven, dish warmer, and water back. The larger ranges have a flue to carry off the products of combustion. There is also a variety of gasolene and kerosene stoves. One novelty in this line is the parlor-lamp stove. It consists of an ornamental tripod supporting a top on which the cooking is done, an ordinary large parlor lamp being placed inside the base. When used for lighting, the lamp is set on top of the tripod. Among the kitchen appliances used in the New York Workingman's Home is the Aladdin oven, invented by Mr. Edward Atkinson, and fully described in this magazine about four years ago.

The greatest novelty in cooking appliances at the fair is unquestionably the apparatus for cooking by electricity, shown in operation in the gallery of the Electricity Building. The electric current is conducted into plates of enamel, where it meets with resistance and is converted into heat. These plates are attached to specially constructed ovens, broilers, griddles, flatirons, etc. An ordinary stewpan, coffee or tea pot, or steam cooker may be heated on the "disk heater." An outfit of articles necessary for a private house costs $60, or $77.50 if a heater for a kitchen boiler is included. Electricity has the same advantages over coal that gas has; its advantages over gas depend upon the fact that combustion, with its needs and limitations, is wholly done away with. There are no products of complete or accidentally imperfect combustion, there is not even a slight loss of heat into the room or up the flue. The strongest points of electrical cooking are comfort and convenience, but claims are made for it also on the score of economy. It is said that the cost of cooking by electricity is less than the cost with coal and about the same as where fuel-gas is used. This is on the supposition that the electricity is furnished at half the price charged for lighting.

Kitchen utensils are no less well represented than are stoves and ranges. The main exhibit of these is in the Manufactures Building. Among them may be mentioned stamped ware enam-

eled in granite and other colors; spiders that will suit both right-handed and left-handed cooks, having a lip on each side; two forms of "self-basting" roasting pans, designed to prevent meats from drying in the oven; knife-edge, torsion, and spring balances; and cast-iron ware polished and even nickel-plated. Portable ovens for gas and kerosene stoves also steam cookers jacketed with asbestos are shown. The jacket prevents the conduction of heat from the cooking food, thus utilizing a scientific principle which is too commonly disregarded in cooking. Cylindrical tin receptacles for flour and meal are shown which may be fastened against the wall at a convenient height. The flour is made to pass through a sieve by turning a crank and comes out by an outlet at the bottom. A measuring cup, which fits on to the outlet when not in use, forms part of the apparatus. There are quite a number of machines worked by a crank which save a great deal of tiresome and time-consuming hand work. One company exhibits a meat chopper, a fruit press, a sausage stuffer, and a cherry stoner. The same company makes a simple utensil, like a saucepan in form, for shaving ice. Another exhibitor has a little nutmeg-grater that is worked by a crank. A small room in the Woman's Building is devoted to inventions by women. Most of these are household articles, while some are of a wholly different character. These inventions are generally modifications of articles already in use, novel departures being rare. Among the cooking utensils in this room are a metal kneading-board, a kitchen knife especially adapted for slicing, a frying pan with a hood and a flue to carry the smoke from the food down into the fire, and an egg and cake beater with a new form of stirrer. Another cake beater invented by a woman, and resembling the tin flour bin described above, is shown in the Agricultural Building. Inventions by women appear also in the Illinois Building, among them being a funnel, a baking pan, and a kettle holder for a stove. A fruit evaporator small enough for household use is shown in the Horticultural Building. The capacity of the smallest size is about half a bushel of apples. In the same building a German exhibitor shows knives of peculiar shapes, for paring and slicing vegetables and cutting them into ornamental shapes; also a cherry stoner. Household woodenware is to be found in the Forestry Building; one make has electrically welded flat hoops set in grooves in the staves, instead of the common riveted hoops; another has welded wire hoops which are imbedded in the wood at several points in the circumference. Near by are shown tubs, pails, keelers, bowls, milkpans, measures, etc., of indurated fiber (paper pulp), which are molded in one piece.

But few appliances are required for laundry work, hence the exhibits in this line are not conspicuous. Of course, wringing

machines are no novelty, but one whose good points are actively exhibited by an attendant attracts considerable attention. It can be put on or taken off the tub with wonderful ease, and adjusts itself to any article from the thickness of a handkerchief up to that of a door-mat. A washing machine for domestic use, shown in the Forestry Building, consists of a round, covered tub with a corrugated bottom and having an axle passing through the cover. The axle carries a corrugated disk on the lower end and is turned by a crank at the top. In the Machinery Building a German invention may be seen. Its tub is three or four feet high and stands on a low frame. It is worked by pushing a lever back and forth. This action turns the drum containing the clothes, and rotates in the opposite direction a stirrer shaped like a four-legged stool. The "self-heating" washer has a box-shaped tub set on legs. Inside is a washboard hung horizontally from a frame, which is pushed back and forth upon another similar board by a long handle. The tub has a metal bottom to which a flame can be applied by means of a gasolene attachment. This attachment can also be swung out and used for making starch or heating a flat-iron. One of the most creditable of women's inventions to be seen is the well-known "cold-handled sadiron," with a detachable handle. Another woman's invention for the laundry, shown in the Woman's Building, is called a "convertible chair," and is described as a combination of clothes rack, ironing board, clothes receptacle, and bosom board. Still another is a waist and sleeve pressing board. Plain laundered articles are shown in the exhibit of the London Board Schools, each piece being marked with the name and age of the girl by whom it was done up. The Lette-Verein, of Berlin, also exhibits laundered articles in the Woman's Building.

One branch of domestic economy which is finely illustrated is the care of children. In the western end of the Children's Building is a large room occupied by the Fitch Crèche and Training School for Nursery Maids. It is fitted up with bassinets and cribs of various styles, one crib being suspended from the ceiling, while on the floor is a square inclosure in which a baby may be safely left to creep about without watching. Here a class of girls is learning the proper care of infants under competent instruction, and here mothers may leave their babies to be cared for through the day while they are seeing the fair. The crèche is an exhibit of the Kindergarten Society of Buffalo. Let no one imagine that sightseers are allowed to wander at will through the room; they can only look in through a glass partition. The middle of the Children's Building is occupied by a gymnasium and there is a playground on the roof, each being suitably fitted up. On the second floor are several rooms in which kindergarten, sloyd, and

other classes are taught. Children's books and papers are shown in the library. In connection with the rearing of children it is perhaps appropriate to mention a collection of photographs of children whose mothers have gone through college, shown in the British educational exhibit. This in refutation of the assertion that college education unfits young women for motherhood.

Ornamental needlework occupies much space at the fair, but useful articles made with the needle are few. In the woman's room of the Illinois Building is a large and attractively arranged case of children's clothing, called the Lilliputian bazaar. Here and in the Woman's Building are a number of women's inventions to facilitate needlework. The women of Manitoba, together with their embroidery and fancy work, send a creditable display of plain sewing and knitted articles. A similar exhibit comes from Uruguay, and, strange to say, is placed in the Agricultural Building, in the space assigned to that country. It is evident that sewing is being made a subject of school instruction in many parts of the United States and also in other countries. The various educational exhibits contain many samples of sewing and mending done by schoolgirls, and the subject is mentioned in a large number of school programmes. Samples of simple millinery, as well as of sewing, appear in the exhibit of the Workingmen's School, of New York. Plain needlework may be seen in the educational exhibit of Japan; also in that of the Board Schools of London. The exhibit of the Lette-Verein, already mentioned, includes plain and ornamental needlework, dressmaking, and millinery.

A few exhibits of a miscellaneous character remain to be mentioned. Three concerns show reversible window sashes, which may be turned into the room, permitting the outside of the glass to be cleaned without discomfort or danger. Among the women's inventions is a wooden roller, covered with some rough material like Turkish toweling, and designed to take up dust from carpets or hard-wood floors. It may be attached to a carpet-sweeper or trundled by a handle independently. With one of the exhibits of domestic hardware in the Manufactures Building is a water motor for driving sewing machines, fans, ice-cream freezers, etc., in any house that has a water supply. Small electric motors adapted to the same purposes are shown in the Electricity Building. These can be used wherever electricity is supplied for lighting, and some are made to be run by a galvanic battery. The water motor can be set in motion and stopped by turning a faucet, and the electro-motors by turning a switch. An interesting application of a scientific principle is seen in a cooler for food, beverages, and provisions, which the agent of a Belgian inventor has placed in the Machinery Building. It is in the form of a high dish cover, is made of tin, and covered with a cloth jacket. The jacket is kept

wet by dipping into a moat containing water, and the constant evaporation from the cloth produces the cooling action of the apparatus. One of the schoolrooms in the Children's Building is a "Kitchen Garden," in which housework lessons with toys are given to very young girls. Its aim, as stated on its placards, is "to take the drudgery out of so-called menial work and elevate the home duties of women by inspiring the pupils with the right way of doing things at an age when life-long impressions and habits are formed." The lessons include waiting on the door, passing a tray, bedmaking, and a broom drill. There is an advanced course for older girls which includes cooking and laundry work. The originator of the Kitchen Garden is Miss Emily Huntington, of New York, who may be consulted daily upon the organization of industrial classes for girls.

Domestic economy has not been omitted from the list of congresses held in connection with the fair. Its congress will be held in the second week of October, under the direction of the Woman's Committee on Household Economics, in the Woman's Branch of the World's Congress Auxiliary. This committee has also been charged with the duty of presenting its subject in the agricultural, labor, sanitary, and other congresses. Unfortunately, more than half the usefulness of all the congresses has been thrown away by holding them seven miles from the center of attraction and in noisy surroundings.

After everything relating to household management has been sought out, the visitor can not resist the conviction that the exhibits at the Columbian Exposition fall very far short of what they might have been and should have been in justice to the importance of the subject. Two of the excellent exhibits of cooking processes are placed in an out-of-the-way spot. Few products of home cookery are shown, and nothing except preserves. Domestic laundry operations are not illustrated at all; laundered articles are sent from schools in England and Germany, but nothing from any American school, and no American woman has shown her skill in washing flannels without their shrinking, colored goods and embroideries without the colors running, or in putting a gloss upon starched linens. In needlework the ornamental has buried the practical out of sight. The difference between the right and the wrong way of making a bed, of sweeping and dusting a room, of cleaning windows and woodwork, and of setting and decorating a table, might all have been illustrated to the great profit of many thousands of visitors. The difficulties in the way of such exhibits are no greater than those that have been overcome in other cases. According to the census, more than half the men of the United States engaged in gainful occupations are occupied with agriculture; and this industry is adequately represented in its

special building and in many of the Western State buildings. An even larger portion of the women of this country are occupied in home management, and it might have been expected that, under the direction of the Board of Lady Managers and in the Woman's Building, some systematic representation of this important occupation would be found. But no; the women of America have preferred to be represented by their painting, their books, their embroidery, their societies for inducing other people to become wiser and better, their work as hospital nurses, by paper lampshades and indescribable things in cardboard and colored wools—by anything, in fact, that is either pretty on the one hand or mannish on the other, or is remote from every-day affairs. This criticism must not be taken as evidence of a wish to restrict women to housework alone. The real feeling of the writer can not be better expressed than by the following words from the preliminary address of the Woman's Committee on Household Economics: "It is not necessary to consider whether woman's sphere is limited to her home—it concerns us to so improve the work done in the home that out of it shall come a power so well trained, by careful study of scientific and economic principles, that it will facilitate and lighten, as well as dignify, household labor."

THE PROBLEM OF COLORED AUDITION.

By M. ALFRED BINET.

MUCH attention has been given lately to the subject of colored audition. It has been discussed in daily journals and in literary and scientific reviews; in medical theses, memoirs, and didactic treatises; it has figured in poetry and romance, and on the stage; it has been the occasion of many inquiries; and physiologists have occupied themselves with it and made laboratory experiments on it.

Notwithstanding all investigation, the subject is still imperfectly known and understood. It has been studied mostly from without. The details concerning the sounds and the associated colors have been carefully noted, but no one has told what colored audition is, or has made it intelligible to those who know of it only from others. We can not hope to be much more fortunate than our predecessors; but we shall direct our attention to the points they have overlooked, and shall try to describe a mental state in colored audition. Let us point out first, in order to gain a comprehensive view upon these questions, the circumstances under which a person first perceives that he has the faculty, as it has been called, of coloring sounds.

Those who for the first time hear these perceptions spoken of experience great astonishment. They can not gain a clear idea of them; the comparison of a sound with a color seems to them wholly destitute of intelligible character. Meyerbeer has said somewhere that certain chords of von Weber's music are purple. What does the phrase mean? Each of the words, taken by itself, has a meaning. We know what a chord is, and we know purple; but joining the terms with a verb and saying the chord is purple, is something we do not understand. As well say virtue is blue and vice is yellow; one is ready to ask if the construction of such phrases is not a trickery of words, which are brought into purely technical associations corresponding to no real association of thought.

Thus, to the immense majority of persons, colored audition is a riddle. This is one of the reasons why the world for a long time refused to believe in it, and treated as eccentrics those who concerned themselves with it—a skepticism which was all the more justified because the matter related to a subjective condition, the existence of which has to be accepted on the simple word of the person who experiences it.

We do not know whether we can make the true nature of this phenomenon understood, or whether we can help those who have not experienced it to conceive of it; but we hope to be able to demonstrate that it is real. Deception has generally an individual character; it is the work of one person and not of many; it gives no occasion for massed effects which are repeated from one generation to another, and in different countries. The number of persons who say they have colored audition must be taken into consideration. According to Bleuler and Lehmann, it is twelve per cent. M. Claparède, of the University of Geneva, who is now investigating the subject, writes us that of four hundred and seventy persons who answered his questions, two hundred and five, or forty-three per cent, had colored audition. Of course, this proportion can not be taken literally, for the immense majority of the persons who do not experience the phenomenon will not answer the queries for many motives, the chief of which is a kind of contempt for studies they do not comprehend. It is nevertheless true that M. Claparède has collected, without great effort, two hundred and five observations, and that that number, added to the old observations, gives a total of nearly five hundred cases. Such a mass of observations may well inspire some confidence. It may be added that each of the authors who have written on the question often has by him the observation of some friend in whom he has entire confidence; so that resistance to so many accumulated proofs becomes no longer wisdom, or even skepticism, but simplicity.

The first author who noticed the production of impressions of color by sounds was an albino doctor of Erlangen, named Sach, who in 1812 described in an inaugural thesis his own impressions and those of his sister. His observation is very complete, and contains a considerable proportion of the details which are found in later works. He died at the age of twenty-eight years, and his researches fell into oblivion. During the following years doctors and oculists, like Cornas, of Geneva, published isolated observations.

In 1873 appeared the important observations of the brothers Nussbaumer, one of whom was a student at Vienna, and the other a watchmaker; both of whom had from childhood experienced sensations of color when they heard certain sounds. When children they observed the ringing of spoons and knives tied to the ends of strings, designated the colors produced by the sounds, and communicated their impressions to each other; but they did not always agree concerning the colors of the different sounds, and long disputes ensued, of which their brothers, sisters, and friends could understand nothing. The student afterward published, under the direction of Prof. Brühl, a detailed memoir on the cases.

Six years afterward, in 1879, Bleuler and Lehmann wrote their memoir, the most complete one we possess. Both authors studied medicine at the University of Zurich; Bleuler writes concerning the origin of this work that they were talking of chemistry, when the subject of ketones coming up, Bleuler remarked that they were yellow, because there was an *o* in the word. Thus by a curious illusion he attributed the colors suggested by the name of an object to the object itself. His friend Lehmann, greatly astonished and not understanding the answer, asked for an explanation of it. This stimulated his curiosity, and they both proceeded to make inquiries among their relatives and friends. They published accounts of more than sixty cases.

From that time publications multiplied, and the present period is marked by investigations pursued in every direction. It now appears that colored audition belongs to a family of similar phenomena, which are sometimes grouped in one person and sometimes scattered. Colored audition is still the most frequent and best studied phenomenon, and is the single one which we intend to discuss. But a word should be said of the other forms. They differ chiefly in the nature of the impressions that are associated, and which serve reciprocally as excitants. Thus, in some persons, not sounds but sensations of taste and odor provoke the luminous impressions. These may be called colored gustation and olfaction. In others, psychical phenomena, like recollections or abstract notions, produce the same effect. One person sees colors in the months, in the days of the week, or in the hours of the day. In

other persons the impression is not visual, but may belong to a different sense. It may be sonorous; in some persons the sight of colors gives a musical impression; or it may be tactile, and sight and hearing may be accompanied by mechanical sensations. In short, all imaginable combinations of different sensations may be realized.

In colored audition the impressions of color are almost exclusively provoked by speech; the sounds and noises of Nature producing the same effect only by a kind of analogy with the human voice. Speech gives him who hears it an impression of color only when the emission is full; a murmur has not the effect of the singing voice or of a reading in public; the height of the tone influences the shadings; barytone and bass voices excite dark sensations and high voices light ones. On a closer examination of the source of the phenomenon it is found that the color, while it may borrow a general tint from the timbre of the voice, and consequently from the individuality of the speaker, depends more especially upon the words that are pronounced; each word has its peculiar color, or we might rather say colors, for some words have five or six; pushing the analysis further, we perceive that the color of words depends on that of the component letters, and that it is therefore the alphabet which is colored; and, finally, that the consonants have only pale and washed-out tints, and the coloration of language is derived directly from the vowels. With a few exceptions this is true for all the subjects.

By a curious complication produced by education, the appearance of colors takes place in some persons not only when they hear the word pronounced or when they think of it, but even when they see it written. There are also persons who do not perceive the color except while they are reading. Many facts, however, seem to prove that reading is generally of no effect except as a suggestion of the spoken word, and therefore constitutes a kind of audition.

The observations on the colors of the vowels in detail are irregular and contradictory. Thus, *a*, red to one, is black to another, white to a third, yellow to a fourth, and so on; the whole spectrum passes through it; but as the number of colors and of letters is limited, we can, by analyzing a hundred observations, meet two or three among them that will agree. Sometimes agreement is manifested between members of the same family, or between persons who live together; but waiving the instances afforded by chance, by heredity, and by suggestion, it remains evident that disagreement is the general rule; and from this curious practical effects follow. Two persons having colored audition, when brought together, are not able to understand one another; each is greatly surprised at the colors which the other perceives, and we

may witness, according to certain authors, some most amusing disputes. Efforts have been made to trace a mean of designations for the vowels, and to indicate the associations most frequently perceived. It is very doubtful whether such statistics can give important results, and whether the correct association can be got from the majority; for the probability must be recognized of the existence of several types of colored audition, which have not yet been clearly distinguished. Furthermore, persons are most frequently incapable of exactly determining and defining the color that appears to them. Their incapacity is associated with the facts that the shading varies not only with the words, but with the elevation of the voice that pronounces them, its timbre, and its accent. A word never has the same color from two different mouths. Consequently there is no definite red for *a* or for any other vowel. Some authors have nevertheless published colored diagrams in which the subjects have tried to represent their colored alphabet. These representations may hold good for colors, but not for shades; it is not that the subjects are lacking in good faith, but they can not fix with precision a color that oscillates and is transformed under the influence of a multitude of intangible causes. We can not stop with describing the phenomena, but must explain as far as we can what passes in the minds of the persons who experience impressions of color in connection with sound. What do they mean when they say, for instance, that *a* appears red to them?

Persons affected with colored audition form a curious illusion respecting their psychological condition. Till the moment, when they are questioned respecting their impressions, they are satisfied that the faculty of coloring sounds is natural, normal, and common to all; and they learn the contrary not without uneasiness. One is never satisfied if he knows that he possesses, deep in his mind, an exceptional trait. All of this kind that is exceptional seems abnormal, and assumes the character of a disease. This opinion is that of many doctors, who would often have much difficulty in defining the condition of psychological health, but imagine that whatever departs from that ideal and imperfectly understood condition is in the domain of pathology. Numerous authors who have written on colored audition have been laudably zealous in comforting those who perceive these impressions. Most—not all of them—have affirmed many times that it is a purely physiological act. We believe they are fundamentally right—but how far?

The phenomenon is often presented in an inexact light. It is easily understood now that it is not a disease of the eyes or the ears, but many authors continue to see in it a disorder of perception, or a double perception, or a confusion of the physiological acts of seeing and hearing.

In colored audition there is no double perception, nor what is called a synæsthesia. All takes place in the imagination of the subject; the impressions of color of which he is conscious on the hearing of certain vowels are not real sensations; they are not colors which one sees with the eyes, but mental images, notions, or we might better compare them with the images which the natural significance of the words excites in the mind. We must insist upon this important and too often misinterpreted point. In order to give a basis to our interpretation, we shall relate some of the facts we have collected with Prof. Beaunis in the Laboratory of Psychology of the Sorbonne; we shall not introduce the detail of the observations, but shall only take the general sense.

To a certain distinguished doctor *a* is red, and is the only vowel which appears to him in color. He has colored it spontaneously from infancy, before having read what was written on the question. The other vowels were not colored till a later age. He is suspicious of the later colorations, and believes that they are fictitious, suggested by reading. Now, what meaning shall we attribute to his expression, so clear in itself, "*A* is red"? Does he mean that when he sees the letter *a* written with a pen on a white sheet of paper, or with chalk on a black tablet, or when that vowel is pronounced in his presence, he has the subjective impression of a red spot which hovers before his eyes, on surrounding objects? In other words, is there a hallucination of sight? In no wise. Still less is there the pretended and incomprehensive seeing of the sound in red. He has the idea of red, and nothing more. It is an idea and not a sensation. According to his own expressions, he receives the same suggestion when he meets in any phrase the word red. Hear, for example, a person who is telling us of some judicial ceremony. In the midst of his story appears the phrase, "Then I saw the procurator rise in a red robe." We have immediately an internal vision of something red—a vision clear, detailed, vivid for some, confused for others. It is a like impression that the letter *a* gives our subject; in short, a simple idea. Let us add that the idea is not very clear; the subject can not define the shade of red that appears to him, still less represent it in real colors, even if he knows how to mix colors and is an amateur painter; it is some kind of a red—unprecise.

If we suppose, now, that all the vowels give rise to suggestions of a similar character, our description will be adapted to a majority of subjects; it will exactly represent their mental state. This mental state is characterized by the direction of the thought toward colors and shades. Each word that presents itself, whether to the eyes in reading, or to the ear in listening, or in a mental conception, gives complex ideas of color. These ideas serve as an escort to the word, accompanying it constantly, and are a second-

ary signification with which the word is enriched. Instead of provoking a single idea, each word provokes two—the idea of the object named, and one or several colors; likewise a phrase awakens, besides a collection of images, a series of colors. On hearing the simple words, "I am going into the country," a person with colored audition has a complex image of a trip to the country, and sees besides passing before the eyes of his imagination a succession of colors which in a subject taken at random might resolve itself into white, red, black, red, white, red, red, red, red, white.

This description may lead us to suppose that useless suggestions of color are an obstacle to the march of thought and might sometimes prevent persons from clearly comprehending the meaning of words and of reading. This case, fortunately, has not as yet presented itself; for the bands of colors do not constantly hold the first place in consciousness. When it is necessary to attend to the meaning of the words we neglect the colorations, do not remark them, and no longer perceive them. To perceive them clearly, and particularly to describe them, special attention is usually requisite, contemplation, a state of reverie, or a desire to enjoy the beautiful subjective colors, the appearance of which is usually accompanied by a vivid feeling of pleasure.

Besides the vague, undefined, and formless color-images which are most frequently provoked, the color is perceived by many persons in a form suggested by the vowel and corresponding with its outline. The language commonly used by such persons to describe their impressions does not always take note of this peculiarity. They simply say, "*A* is red." This means, in the present case, that when one thinks of the letter *a* he can not represent it otherwise than under the form of a letter painted in red. This variety of colored audition is more refined than the preceding, and also more complex; for it can not be found in an illiterate person, and supposes that one knows how to read. Mr. Galton has published five or six observations of this kind with figures.

Persons who have colored audition and who are cognizant of it easily recognize the nature of their subjective impressions. They regard them as personal associations with nothing mysterious about them, and some even seek for their causes in the most commonplace and trivial circumstances. But if we cause them to describe their way of hearing, we perceive that they involuntarily attribute to these associations much more importance than they say they do. It appears that most frequently the idea of color suggested by a word is referred, not to the word itself, but to the external object designated by the word. There results from this the interesting consequence that as there are words designating some object of a red color which, on the other hand, provoke by

their vowels the idea of a different color—for example, gray—the discord appears shocking, and the subjects do not hesitate to declare the word ill-formed. A doctor, a friend of ours, to whom *a* (French) is red, finds also that the word *feu* (French for fire) is incorrect, because fire is red and the word *feu* has no *a*. A correspondent to whom colored audition is a multicolored palette makes similar remarks on the contradictions or confirmations which he finds between words and their colors. To him *a's* are red, as to the doctor; hence he finds that red (*rouge*) is ill-named, and that the word fire (*feu*) is "that which is dullest"; scarlet (*écarlate*) is, on the other hand, quite imitative. *I* is black and *o* is white; whence it results that the word *noir* (black) is white and black; to pronounce the words *moire rouge* is to think of a contradiction. These plays with words, of which we might cite numerous examples, seem to us to indicate a tendency to give a real significance to associations of sound and color, as if they expressed a truth to which language ought to conform. But the subjects are too intelligent to affirm this; they simply yield to the sway of thought, without being aware of it.

There are other persons in whom the same tendency is manifested in a clearer and more simple way. They believe in good faith that certain things they have never seen have precisely the color of the word by which they are named. We have mentioned Bleuler, for example, who thought the ketones were yellow, because of the *o* in the name, to which he attributed that color. Observations of this kind need not be enlarged upon. For a person to believe that a thing is red because there are red vowels in its name, he must not be acquainted with its real color, and must not be aware of his faculty of coloring the vowels; for the illusion will disappear as soon as he perceives that the supposed color depends on the word. These are probably the conditions of the following observation of which I have been informed by M. Claparède. A person fifty-two years old wrote to him: "I still remember the astonishment I felt at the age of sixteen years when I saw sulphuric acid for the first time. I had previously read an account of that substance in a work of popular science, and had fancied it an opaque liquid, having the appearance of tarnished lead. I was then not yet conscious of my colored vision of the vowels. Later in life I explained my fancy as related to the two *u's* in the word sulphuric." This person saw *i* as black, and *u* as a lusterless metallic gray.

The same tendency, but with a very different effect, appears in a lady observed by M. Suarez de Mendoza, who attributes a special color to each piece of music and each score. The music of Haydn appears to her of a disagreeable green; that of Mozart, generally blue; Chopin's is distinguished by much yellow;

Wagner's gives the feeling of an atmosphere of light, changing its colors in succession.

Having established the mental nature of the impressions of color, we come now to seek the cause of their apparition. We know pretty well what one means when he declares that *a* is red; but we have not explained how the idea or perception of a sound can awaken the idea of a particular color. Our ideas have generally a logical origin; we are at least in the habit of believing this, and it often occurs, in analyzing our representations, that we find the cause that brings them out and connects them. If I hear a bell, and, without seeing it, conceive its roundish form, its clapper, and its dark-green color, the connection of ideas is understood to be natural, useful, and true; it is derived from previous experiences. It is a piece of the outer world registered in my mind. But these associations of colors with sounds are factitious, have a purely individual character, and correspond with nothing in the order of external facts. A sound is a sound, and has nothing in common with a color. The human voice is grave or sharp, and is not yellow or green. How has such an association been created and developed in the face of good sense? It is evident that the act of establishing tenacious associations between impressions that have nothing in common is the sign of some intellectual form which is not everybody's. We are disposed to attach some importance to the quality of the illusions evoked. They are of a visual character, which seems to indicate that there exists in colored audition an intense rush of visual images and a tendency to think as well as to feel with them; in short, we suppose that those who have colored audition belong to the category of visuals, or persons who, according to the classification of M. Charcot and many physiologists following him, have visual memories. As the case of M. Inaudi enabled us to study a high development of the auditive memory, another category in this classification, colored audition, will perhaps permit us to study visual memory. This is only a hypothesis; for it is not absolutely certain that colored audition always agrees with the type of visual memory, and that there is a causal relation between the two things, but we do not advance it without the support of good reasons.

First, we have the testimony of the subjects whom we have had opportunities to question. We addressing them in a tone of indifference and without trying to dictate their responses, they have remarked that colors and forms are the things they remember most easily. A young woman to whom I sent my requests in writing to avoid the unconscious suggestions of accent, answered me, "You ask me if I more easily recollect things seen or things heard; things seen. When I recollect a conversation, the gestures

and the attitudes of the participants recall to me what was said. Successive pictures present themselves before my eyes, and those pictures enable me to call back what I heard." That is a real visual type. In determining the type, it is necessary also to take account of the tastes of persons, their aptitudes, and their favorite occupations. Most of those whom I have seen, practice at painting or water colors, and some are painters by profession; others have been drawn by circumstances into different careers, but nearly all of them love color and Nature and have a passion for beautiful hues. Take notice also of their language. Whenever they describe their mental condition they have a marvelous abundance of picturesque expressions. Mr. Galton has justly remarked that few of those who have colored audition are satisfied with laconically naming the colors of the vowels; they must exactly define the shade, even if they are talking of white—a sensation so simple and apparently so easy to define without an epithet. They do not say, "*O* is white," but rather "*O* is a shade of white, the color of white plush, or of the under side of a fresh white mushroon." Another will say, "White mingled with milky and a little yellow"—or silver white, chalky white, etc. The use of these expressions informs us concerning the chromatic sense of these persons. They are colorists without doubt. We who have dull imaginations have the same words at our disposal as they, but we are unable to draw the same effects out of them. Words are like the colors we use in painting. Give two identical palettes to two painters, one of whom is a colorist like Delacroix and the other a draughtsman like Ingres; with the same colors one will produce a brilliant and the other a subdued picture. What permits us to give color to the canvas, as well as in the expression of our ideas, is, above everything else, the power of mental vision.

Our hypothesis is confirmed by some facts that have been brought out in M. Claparède's investigation of "visual schemes" or such figures as Mr. Galton has found some persons associating with their groupings of numbers, and which M. Claparède has found may be associated with other abstract conceptions, like the months and the days of the week. The results of his inquiry showed a frequent coincidence of colored audition with the faculty of forming such visual schemes. Without employing visual schemes, many persons represent the figures mentally to themselves as if they were written out—a method of representation which is another good characteristic of their type of memory. I have made an experiment on this point, instructive to me, which repeated upon a number of persons has always given concordant results. I pronounce five numbers to a person and ask him to repeat them; then six, and then seven, till the

number pronounced is more than the person can repeat exactly. I then ask him abruptly if he saw the numbers or heard them in his memory. Remark that this experiment appeals by its method wholly to the auditive memory. In nine cases out of ten, taking the subjects as they come, they will answer that they heard the numbers "in their ear," and had no idea of seeing them; or, if they saw them, it was by a confused, indirect mental vision. But those persons who have colored audition will answer that they saw the numbers. Although their auditive memory was excited by hearing, they transformed the auditive image of the number into a visual one; their attention was fixed on the form, the color—an excellent example of that tendency to transform everything into visions which seems to me to be the characteristic of colored audition.

This mental organization agrees in many of its characteristics, with that of the painter, the mark of whose vocation may be found, as M. Arréat has indicated in his La Psychologie du Peintre, in his sensitive eye and his aptitude in appreciating, abstracting, and reproducing the brilliancy of colors and the harmony of forms, from which he acquires a habit of thinking with visual images. The natural gifts of the painter are, however, not all that is required for colored audition, but are only one of the psychological conditions of the phenomenon. A person capable of recollecting colors with their most delicate shadings might, by giving free course to his poetic imagination, color all the sounds that vibrate in his ear; but he would only arrive at intentional comparisons which he can make and unmake at will. The association in colored audition is very different; it is not sought for or selected; the subject does not invent it, he finds it already formed in his mind. He has only to hear a voice to have almost instantly the impression that that voice has a certain shade of color. Here we touch upon the fundamental characteristic of colored audition. Since it consists of an artificial and insurmountable association, it can not be regarded as a strictly physiological condition; it is a deviation, however insignificant we may suppose it to be, from the usual normal course of thought. Yet it generally coincides, according to the observations of the best authors, with a perfect state of physical and moral health, with perhaps a slight predominance of the nervous temperament in the majority of the subjects. The influence of heredity has been noticed several times. There have been as many as four or five cases in the same family, and considerable resemblance between the colored alphabets of relatives.

If the ultimate fundamental origin of colored audition is, as we beieve, in the organization of the individual, it remains to find the occasional cause that determines it and establishes a precise

connection between each kind of sound and a color. We should not suggest the problem if we thought it impossible to solve it by some direct method, and we have a firm hope that well-conducted personal investigations will at length discover the origin of the association. It may be that some importance may be attached to the picture reading books in which the letters are colored for the pleasure of children. Possibly, too, the consonance of certain words designating colored objects has been detached, by a kind of abstraction, from the word itself, and has carried the reflection of its color to other words in which it is found, although their meaning is entirely different. This second opinion is supported by an observation cited by Mr. Galton, of a lady who gave *e* the color of red, and believed it was because there is an *e* in the English word *red.*

We may summarize the knowledge we have concerning the mechanism of colored audition as follows: It is certain that the impressions of color suggested by certain acoustic sensations are mental images; it is probable that those persons who experience these impressions belong to a visual type; and it is possible that the bond between the impressions is the result of associated perceptions.—*Translated for The Popular Science Monthly from the Revue des Deux Mondes.*

SOME CHARACTERISTICS OF NORTHWESTERN INDIANS.

THE Kootenay Indians, who number between five hundred and a thousand persons, inhabit a strip of country between the Rocky and the Selkirk Mountains, partly in the United States and partly in British Columbia. As a rule, their moral character and behavior are good, and they are honest, kind, and hospitable; but a few incidents cited by Dr. A. F. Chamberlain, in his report concerning them to the British Association, indicate that they are sometimes moody and easily offended, especially when their demands are refused. They have also a keen sense of the ludicrous, and laugh at the misfortunes that befall their fellows. A favorite Sunday amusement among the Lower Kootenays is horse-running. "All the horses are assembled in a large, open space near the camp, and the Indians form a large circle round them, and, provided with long whips, they drive the horses to and fro for an hour or so, laughing and yelling to their hearts' content. Even the little boys take part in this sport. They also take great delight in breaking stubborn horses, and the whole camp looks on until the young man has succeeded in controlling his animal, guying him unmercifully if he makes mistakes." Although no

picture-writing upon rocks has been attributed to them, they have marked artistic ability, and exhibit their skill in ornamentation upon articles of dress and the implements of the chase. Indians who had had no instruction in drawing from the whites, employed by Dr. Chamberlain to make a series of drawings, drafted very good maps of their country, and seemed to have well grasped the idea of their work. Some of them were also able to recognize with ease the various physical features prominent in the printed maps of the Kootenay district. Their drawings of weapons, implements, etc., were excellent, and those of one of them in particular would never be suspected of being the product of aboriginal genius. "Pictures of houses, railway trains, etc., have a certain conventionality that is characteristic of savage races. Several of the Indians were able to draw an excellent and easily recognizable picture of the little steamboat that plied up and down the Columbia River. In their drawings of human beings, especial stress is laid upon the distinguishing features, and any peculiarity or abnormity is brought out with full force. Thus, a Stony Indian woman has no nose, a Chinaman has an immense single braid of hair, a white man an enormous beard, a certain Indian a colossal nose, and the like."

They have fourteen distinct names for colors, and their horses may be white, black, half white and half black, roan, "buckskin," "blue," sorrel, or mouse-colored.

The social position of women is not greatly different from that among the other surrounding tribes. Girls may be married at fifteen and young men at twenty years of age. In the olden times the young Indian wishing to marry "went at night to the lodge where slept the object of his affections, and, quietly lifting up the blankets to make sure, lay down beside her. The girl's people soon found him there, and threats were made. The young man's father meanwhile inquired where his son was, and, on being told that he was in such-and-such a lodge, went thither with his friends and discovered the young people together. The girl then left and went with her husband to his own people. He was at liberty to send his wife back to her relatives within a year if she turned out to be bad or he was dissatisfied with her. When guilty of adultery she was punished by having one of her braids cut off by her husband." Descent seems to be traced through the mother.

Private property in land was unknown, the country belonging to the tribe collectively; and demands for money are still made by the Lower Kootenays from any stranger intruding upon their domain. The hunter had no absolute right in his game, and it was distributed among the camp in order that all might have food. Women could hold property as well as men. The horses

were the property of the grown-up male children, as well as of the father, and could be gambled away by any one of them. The lodge seems to have been secured to the widow and children on the death of the father. The women inherited the kettles and other utensils, besides their saddles, blankets, "parfleshes," etc. The horses, canoes, weapons, etc., went to the male children if they were of age. In early times the dead man's relatives would swoop down upon the lodge soon after his death and appropriate the property substantially at their will. If the dead man left no relatives, the "strong man" of the tribe took possession of his property.

The Kootenays paid a worship to the sun, and they believed in the existence of spirits in everything animate and inanimate; even little stones, bits of rag, shavings of wood, have their spirits. These spirits can go anywhere, through glass, wood, or any substance, as through air. The touch of them causes death and disease. At the death of Indians their spirits may enter into fishes, bears, trees, etc.; in fact, into anything animate or inanimate. When a man is alive his spirit may exist in the form of a tomtit, a jay, a bear, a flower, etc. The spirits of the dead can return and visit their friends. In olden times sacrifices appear to have been made to the spirits of the mountains and of the forests to secure success in hunting, and to appease them when they were angered. Their language is supposed to differ from the ordinary Kootenay. A great or strong man has many spirits. The spirits were supposed to come often at the prayer of the medicine men, in the form of birds or the like. A tree is pointed out in the Kootenay region, in northern Idaho, from which Indians have jumped off on two successive occasions, in obedience to the promise of the medicine men that they should be able to fly like birds if they did so. Certain death, of course, awaited them. The shamans treated the sick by pressure upon various parts of the body, by pinching, etc.; practiced bloodletting, and pretended to extract the cause of the malady by suction with the mouth.

In the astronomy of the Kootenays the moon is regarded as a man and the sun as a woman. There was no sun in the beginning, and, after the Indians had vainly endeavored to discover it, the coyote was successful in making it rise above the mountains. Another version makes the chicken hawk cause the sun to rise. The coyote, getting angry, shoots an arrow at the sun, but misses, sets the prairie on fire, and has to run for dear life. The moon is said to have been found by the chicken hawk. A legend about the man in the moon may be of European origin. The stars are mostly Indians, who from time to time have got up into the sky. The Great Bear was an Indian woman, who sometimes was very angry; and the stars in her tail are Indians whom she has seized.

The Milky Way is the dog's trail. The thunder is caused by a great bird that lives far up in the sky. The lightning is made by the shooting of its arrows. At first there were no clouds. The daughter of the coyote married the thunder, and her father gave the clouds for a blanket. The Kootenays believe that they came from the East; and one of their myths ascribes to them an origin from a hole in the ground east of the Rocky Mountains. Another account says they sprang from the hairs of the black bear, which fell on the ground after he came out of the belly of the great fish that had swallowed him. There were no women at first. By and by an Indian went up into the mountains, and from a spirit who lived there received the first Kootenay woman. The origin of horses is ascribed to a medicine man who made a stick into the shape of the animal and then threw it away, whereupon it became a horse. The belief prevails that the white men get their cattle from the sea. It is said that they go every year to the Pacific Ocean to receive the cattle which come out of the waters. Many of the animal myths remind one of Uncle Remus.

Some very interesting legends are related by Prof. George W. Dawson as communicated to him by Mr. J. W. Mackay, Indian agent at Kamloops, from the stock of the Shuswap Indians. Like most of the Indian people they have a culture or creation hero with supernatural attributes, who with them figures as a coyote or small wolf, and is named Skil-ap. In the old times the salmon could not ascend the Fraser River on account of a dam which two old witches had made at Hell-gate Cañon. He told the people he would go down the river and break the dam, so that the salmon could come up, and instructed them that he would make his approach known by a great smoke. He transformed himself into a smooth, flat piece of board, floated down to the dam, was picked up by the women, who undertook to use the board as a plate, emerged from it as a child, and was cared for by them, till one day when they were absent he put something on his head that made him invulnerable, and destroyed the dam, after which the salmon began to go up in great numbers. Then he followed the bank of the river, keeping abreast of the vanguard of the salmon, and making a great smoke by setting fire to the woods as he proceeded, so that the people knew that he was coming. Near the outlet of the Kamloops Lake he stopped to eat, and made a fish weir at a spot where some high rocks may still be seen. At the mouth of the Clearwater he completed a salmon dam he found the people making; and there are to the present day steep rocks on either side of the river, and above them a large pool or basin where he fished with his scoop-net and which is still a noted salmon-fishing place. On the rocks may be seen the prints of his feet where he stood to fish. Thus the salmon were

enabled to ascend into all the rivers of the Shuswap country. Skil-ap is expected to return at some distant period when "the world turns" and the good old days come back.

There were in the early times of Skil-ap other supernatural beings who roamed the world, the most important of whom was named Knil-i-elt; and it may be, Prof. Dawson suggests as a point worthy of inquiry, that in the stories related of Knil-i-elt and Skil-ap we find the mingling of mythological ideas derived from two different sources. Knil-i-elt had no recognized father or any relative but his mother, and was the offspring of the union of the woman with a root which is eaten by the Indians. Learning the mystery of his birth after he had become a great hunter, he reproached his mother concerning it, and said he would go away and never return to her. She then told him of all the evil and malignant monsters living in the country farther down the river, and he resolved to extirpate them. Among his exploits was a trial of strength with two friends, in which each should push his head against a rock and see which could make the deepest impression. Each of the friends made a shallow indentation, but Knil-i-elt pressed his head in to the shoulders. Impressions in the rock are still shown by the Indians, and Hat Creek, near the mouth of which they were made, was named from the incident. A conflict with the eagle monster resulted in the death of the eagle and the capture of its eaglets, pulling out the tail feathers from which, Knil-i-elt reduced them to common eagles, able to harm no man. At the outlet of Kamloops Lake was an elk monster that lived in the middle of the river and killed and ate men. Knil-i-elt, having made a raft, embarked and floated down the stream, when, before long, the elk seized and swallowed him. His friends, who were looking on, thought they had seen the last of him, but Knil-i-elt stabbed the elk to the heart with the weapon he carried, and then cut his way out of its belly and came to shore, bringing the elk with him, and invited his friends to eat some of the meat. He then reduced the elk to its present position, saying to it: "You will no longer kill men; they will in future always kill you." The badger was also in this early time a formidable monster, and had its lodge stored with dead men, collected for food. Knil-i-elt caught the badger, and striking him on the head said, "Hereafter you will be nothing but a common badger, able only to fight with dogs when they attack you." He further brought to life again all the people whom he found dead. Knil-i-elt met his fate from four witches, whose supernatural power was superior to his, and who turned him and the two friends who had accompanied him in all his adventures into stone.

On the trail leading from Kamloops toward Trout Lake the scanty remnant of an old stump protrudes from among a few

stones which are piled about it, in passing which the Indians always throw some little offering upon it—such as matches, a fragment of tobacco, or a shred of clothing, which were seen by the author. The story attached to it relates that a lonely woman called Grizzly Bear made of pitch the figure of a girl to be a companion to her, who became her daughter. She warned the girl that when she bathed she must not afterward sit or lie in the sun to get warm. The girl tried the forbidden experiment after her fourth bath, and was melted away. Grizzly made another daughter of clay, and told her that she must not rub herself when in the water. This girl disobeyed likewise and was washed away. The old woman than made another daughter of wood, on whom it was not necessary to impose restrictions. This girl, after a fourth bath, was accosted by a trout, which she said she would like for a husband. On repeating her wish the fourth time the trout appeared as a young man, became her husband, and took her with four efforts, the first three of which were balked, to his lower country. A boy and a girl were born to this couple. They were taunted about having no grandmother, and, questioning their mother on the subject, were told that they had a grandmother living in the upper country. They might go up there and would find her as an old woman digging roots on the hillside, but must not speak to her, though they might go to her house and eat whatever food they might find there. The children acting upon these instructions, the woman missed the food, and, observing the footprints of the children, concluded that none but her daughter's children would visit her house in that way. She therefore prepared some potent medicine, and, going to a stump in the hillside where she was accustomed to work, told it that when the children appeared it must move and seem to be a woman digging. The woman then concealed herself in the house, while the stump acted as it had been bidden. The children, after regarding the stump for a time with some doubt, ventured into the house, when the woman threw her medicine upon them. The medicine fell all over the boy, who was changed to an ordinary human being, but only partly over the girl, and she became a little dog. The boy and the dog, in whom he failed to recognize his sister, had some curious adventures, in the course of which he learned the truth. He went to his grandmother and questioned her on the subject. She told him that if, when shooting, his arrow should lodge in a tree, or anywhere above his reach, however little, he must not climb up to get it. Soon afterward he lost three arrows in this way, but a fourth time his arrow stuck in a tree not far up, and he climbed on a branch to get it; but the arrow continued to move further up and he had to climb after it, and though he thought that he had not gone very far, he looked

down after a time and found that he could not even see the earth. So he went on climbing till at last he reached another country above, which was very pleasant and populous, and there he remained. The old stump by the wayside is the remnant of that tree.

Another curious story relates to a mosquito gorged with blood, which flew up where the thunder is. The thunder asked the mosquito where it got the blood, and the insect falsely replied that it was sucked from the buds at the very top of the trees below. Hence the reason that the thunder (or lightning) strikes the tops of the trees.

Some curious myths are associated with particular places. The lakes are supposed to be occupied by peculiar beings called "water people," who are alleged to have remarkable powers and to use them in performing strange acts. It is dangerous for canoes to pass Battle Bluff, on Kamloops Lake, because of the water people, who in this instance are described as of human shape, but hairy in the upper half, with fishlike tails below. It is also told of this bluff that some hostile people, once coming by land to attack the Kamloops Indians, looking down over the front of the bluff as they passed, saw a woman or witch dancing in a niche part way down the cliff. They sat down on the edge of the cliff to watch the woman dance and were turned to stones. "Little men" are reported to exist in several places, to hunt with bows and arrows, to be only two feet high, and yet able to carry a deer easily. In contrast to this, when a squirrel is killed, they skin it and take only a part, as the whole is too heavy for them. The Indians are very much afraid of them. The Indians aver that unknown beings sometimes throw stones at them, particularly at night, when stones may be noticed occasionally falling into the fire. A Kamloops Indian, long since dead, once saw a white object following him by night. He drew back from the trail and shot an arrow at it as it passed. In the morning he returned and found his arrow buried in a human shoulder-blade. It is believed that burning wood from a tree which had been struck by lightning brings on cold weather. This appears to be based on the fact that cold follows a thunderstorm. Thus, in the spring, when Indians may be traveling over the snow on high ground, splinters of such wood are thrown on the fire to reduce the temperature, in order that the crust may remain unmelted on the snow. A small splinter of such wood wrapped up with the bullet in loading a gun is supposed to increase the deadly effect of the bullet. The plant *Parnassia fimbriata*, worn in the hat or rubbed on it and on the soles of the feet, is believed to make it certain for the deer-hunter that the deer will be seen and caught. The rattle of a rattlesnake is worn as a preventive against headache.

The Pleiades are called by the Shuswaps "the bunch," and also "people roasting." The latter name is given from a story of their origin, which relates that a number of women who were baking roots in a hole in the ground were changed into this group of stars. The morning star has the names "coming with the daylight" and "one with hair standing out round his head." The four stars forming the bowl of the Great Dipper are known as the bear stars, and the three following large stars are three brothers in pursuit of the bear. The first hunter is brave and near the bear; the second leads a dog (the small companion star); and the third is afraid and hangs far back. The stars of Orion's belt are called "fishing," and the Milky Way is the road or path of the dead. The months, beginning about March, are "spring," "grass month," "root-digging month," "strawberry month," "berry month," "salmon month," "month when the salmon get bad," "month when the deer travel," "month in which they return from hunting," "midwinter month," and *Pit-tshik-in-tin*" (which is not translated).

Several native roots still constitute notable items in the food of the Shuswaps, though their importance has diminished since the white man's preparations were introduced. Roots are always dug and cooked or cured by the women. In digging the roots a pointed stick, about four feet in length, with a crutch-shaped handle, is used. The lily, *Lilium columbianum*, is much sought after, and, like most of the roots, is cooked by baking in the ground. The roots of balsamorhiza, cinquefoil, claytonia or spring beauty, dog-tooth violet, and of other less familiar plants, are also eaten. The camass is abundant, and forms an important article of diet. No edible thing is ignored, and few edible substances of any kind are passed by; but the Indians never heard of any one eating a mushroom. The cambium layer of the black or bull pine (*Pinus murrayana*) is eaten when it is soft and gelatinous, at the time the leaves are still growing, and is sometimes dried and kept. The cambium of the subalpine spruce and of cottonwood is also sometimes eaten. The sappy and still nearly white parts of the large leaf-stalks and stems of the *Heracleum lanatum* are eaten in the spring, and, when taken at the right stage, are not much inferior to celery. The nutlets in the cones of *Pinus albicantes* are gathered in large quantities and eaten from the cones after having been roasted, or thrashed out and prepared. They have a rather pleasant taste, flavored with turpentine, and are nearly the size of small garden peas. Nutlets of yellow pine and Douglas fir are also collected—generally by robbing the mice and squirrels of their stores. The pith or inner bark of *Epilobium spicatum* is eaten while still young and sappy. A black, hairlike lichen, *Alectoria jubata*, is eaten roasted, and is

said to taste very sweet. A yellow lichen furnishes a coloring matter, and the root of a certain fern (*Asplenium* or *Aspidium*) yields a black dye. The leaves of the syringa (*Philadelphus lewisii*) were formerly used as a soap in washing clothing. The fiber plants are an *Asclepias* or milkweed, and the common nettle of the country.

The sweat-houses of all the Northwestern Indians are very much alike. They consist of a dome-shaped framework, formed by bending willow sticks over one another, covered with blankets or skins or earth, and a pile of hot stones in the center, or a hole in which hot stones are thrown. The Indian takes his place in the booth, and water is thrown upon the stones. The bathers sit in a suffocating temperature till they have had enough of it, and then rush out and plunge into the water, which they take care to have always near.

SKETCH OF WERNER VON SIEMENS.

WITH Werner Siemens, says a German biographer, died a prince of science, a pathbreaker in the region of electrotechnics, a man whose activity extended far beyond his own narrow district, bearing fruit in other branches of human achievement; one of the greatest industrial characters, not of Germany only, but of the whole world; an industrial character, however, to whom gain was never an object in itself, but who rather found in it the incentive to new scientific studies.

ERNST WERNER SIEMENS was born at Lenthe, Hanover, December 13, 1816, and died in Berlin, December 6, 1892. He came of a family very rich in offspring—while he was the eldest son among ten children. His father, Christian Ferdinand Siemens, was a tenant farmer and forester, who had qualified himself for his profession by studying at the school at Ilfeld and the University of Göttingen. He afterward went to learn practical agriculture with Councilor Deichmann at Poggenhagen, where he married the councilor's daughter, Eleanora Deichmann, preparatory to settling upon his estate at Lenthe.

The English think they have a kind of birthright claim upon Werner Siemens, because, at the time of his birth, the King of England was Elector of Hanover. The connection is not entirely flattering to them, for the elder Siemens fared hardly at the hands of King George. He was arrested and fined for detaining some royal deer which had trespassed upon his premises while awaiting the answer of the gamekeeper to his inquiry as to the disposition he should make of them. To escape such unpleasant incidents the elder Siemens removed, in 1823, to Menzendorf in

Mecklenburg-Strelitz. Werner Siemens's earliest recollection of his life at Lenthe was of what in his Reminiscences he calls an act of heroism. When he was about five years old his sister came crying into his father's room where he was playing. She had been sent to the Pfarhaus to take her lesson, but found her way obstructed at the gate by a gander, which snapped at her whenever she attempted to pass. The father gave Werner his staff and told him to go with his sister and to cudgel the gander well when it appeared. The boy did so, and the gander ran away in panic. "It is remarkable," he says, "how deep and enduring an impression this first victory made on my childish mind. Even now, after nearly seventy years, all the persons and scenes connected with this important event stand clearly before my eyes. With it is also associated my only recollection of the appearance of my parents in their younger days; and many a time, in later difficult experiences, has the victory over the gander unconsciously incited me not to shun threatening dangers but to meet them with vigorous resistance."

The Siemens children were taught by their grandmother Deichmann, and then by their father, whose brilliant and original sketches of history and ethnology, dictated to them, formed the foundation, Siemens says, of his later views. He was next sent to the *Bürgerschule*, in the neighboring town of Schönberg, whither he walked when the roads were not too bad, and where he seems to have spent a year of battling with his mates, "to the hardening of his powers, but with only the most insignificant results in knowledge." Then he had tutors of opposite characters, and after them he was sent to the gymnasium at Lübeck. Not satisfied with the progress he was making in mathematics and in the ancient languages, he gave his attention to the only technical branch taught in the school—engineering. To prepare for entrance into the engineering school at Berlin, he took private lessons in mathematics and surveying. Instead of entering this school, which was expensive, his teacher advised him to go into the Prussian engineering service, where he would be taught the same things. His father fell in with this plan, and prophetically gave as his reason that the present conditions could not last in Germany, that in time everything must go down. The only firm point in Germany was the state of Frederick the Great, with the Prussian army; and in the time of trouble that was coming it would be better to be the hammer than the anvil. Fortune favored him in the examinations, for which his preparation had been very superficial, and in the fall of 1835 he was admitted to the United Artillery and Engineers' School in Berlin. His mother dying in July, 1839, and his father six months later, he became the guardian of his younger brothers and sisters. Some

experiments he was making at this time with friction fuses ended in an explosion, by which his hearing was permanently injured.

While Siemens was stationed, in 1840, at Wittenberg, he became interested in the discovery, then recently made by Jacobi, of the precipitation of metallic copper from the sulphate by means of the galvanic current. He repeated the experiments successfully, and applied the process—so far as his means would permit—to other metals. His studies were interrupted by his arrest and imprisonment for connection as second with a duel between two of his brother-officers. Not relishing the idea of spending an indefinite period in idleness, he managed on his way to the citadel to make arrangements to have the materials required in his electroplating researches smuggled in to him. He set up a small laboratory in his cell and made himself contented there. Recollecting, from experiments he had made in the Daguerrean process, that hyposulphite of soda would dissolve the insoluble salts of gold and silver, he applied the principle to electrolysis with astonishing success; and he believes, he says, that it was one of the greatest joys of his life when a newly silvered teaspoon which he had immersed at the zinc pole of a Daniell cell into a cup filled with a hyposulphite gold solution, while the copper pole was connected with a louis d'or as an anode, "was converted in a few minutes into a gilded spoon of the most beautiful, purest golden luster." Galvano-plating was then new in Germany, and his discovery made much talk. A jeweler of Magdeburg, visiting him in prison to examine into its merits, he sold him the right to use it for forty louis, and thus obtained means for continuing his experiments. He counted upon enjoying still several months of captivity, and the unmolested prosecution of his researches, when the unwelcome message came to him of a royal pardon, and he was obliged to leave the citadel at once, without house or other spot in which to set up his apparatus. He asked leave from the commandant to stay a little longer, but was denied, accused of being ungrateful for the royal clemency, and was hurried out of his quarters at midnight. He had gained by his experimenting the reputation of not being well qualified for practical work, and was assigned to the fireworks factory at Spandau. He had great success in making pieces of unexampled brilliancy for the birthday celebration of the Emperor of Russia, and was invited to compete in a sailboat race with Prince Frederick Karl—and beat him. Then he was ordered to Berlin, to serve in the artillery arsenal; to his great delight—for this commission would give him time and opportunity for carrying on his researches.

Wilhelm Siemens having completed his studies and constructed a steam engine, Werner furnished it with a differential regulator. He made a profitable contract with a silver-ware

house in Berlin for the use of his plating apparatus, and Wilhelm was dispatched to England to introduce the inventions there. Besides the galvano-plating patent, which was sold to Elkington & Co. for £1,500, there were processes for nickel-plating and for anastatic printing, etc. A journey to London to assist Wilhelm in some financial difficulty, in which he visited Paris and Brussels on his return, gave him new and higher views of his work, while its results satisfied him that the road to wealth did not lie through speculation in inventions. He entered upon a more thorough course of study, formed associations with the young naturalists of the time, some of whom have since become famous, joined in the foundation of the Physical Society, interested himself in the Polytechnic Society, and sought to promote the technical applications of science. He became acquainted with manufacturers, and published articles in the scientific journals on "The Application of Hot Air as a Motive Power," in which he accepted Mayer's and Helmholtz's doctrine of the conservation of force; describing his differential regulator; and "On the Application of the Electric Spark to the Measurement of Velocity."

Werner Siemens became warmly interested in the experiments which Leonhardt was making, at the instance of the general staff of the army, in the substitution of an electrical apparatus for optical telegraphy. He had seen a model of Wheatstone's telegraph in the house of one of his comrades, and had tried to establish a communication between the house and a mineral-water establishment across the garden. He devised an improvement in the apparatus for generating and controlling the current, which attracted the attention of the mechanician Halske, who eventually gave up his business and associated himself with Siemens in telegraphy.

Siemens's plans were again embarrassed by the results of his and his companions' inconsiderately signing a paper connected with the religious movement of John Ronge, which was considered seditious. His brigade, to punish the offenders, was ordered to a retired post. It was important for him to remain in Berlin to prosecute his researches, and he devised a means to induce the Government to keep him there. Schönbein had made his first discovery of gun-cotton, but the material he produced was poor and unreliable. Siemens spent a day in experimenting upon it; added treatment with sulphuric acid, and obtained a certain and really practicable explosive. He communicated his discovery to the Minister of War, and was ordered to continue his experiments at the Spandau Arsenal, while his punishment was forgotten. Unfortunately, Prof. Otto, of Brunswick, who had independently discovered the same method, anticipated him in publication, and thus deprived him of the credit of priority.

Having communicated with General Oetzel, the chief of the military telegraphic service, he was invited to assist in the substitution of electric for optical telegraphs. He gained the confidence of the general and of his son-in-law, Prof. Dove, and was commissioned to carry out his own plans. The lines were to be put underground, and there was difficulty about finding satisfactory insulating material. Wilhelm Siemens had sent him some specimens of gutta percha from London as a curiosity. It was found eminently adapted to the purpose of an insulator. With a press supplied by Halske, the wires were successfully covered, and the lines were established with Siemens's instruments. In October, 1847, the firm of Siemens and Halske was formed, which, beginning in a rear building with a modest capital, was destined to ramify till it had branches in several of the capitals of Europe, and became prominent in the construction of Continental telegraphs and the world's cable lines.

The revolutionary movements of 1848 brought the extension of telegraphic enterprises to a temporary halt. The Siemens-Halske establishment, nevertheless, went on with its work, though it had no orders. In a short time Siemens was commissioned to lay submarine electric batteries in the harbor of Kiel for protection against an apprehended attack by Danish vessels. Having assured the perfect working of his mines from the shore, he collected a band of volunteers in the city and surprised the post of Friedrichsort, at the entrance to the harbor, under the protection of which, it being held by the Danes, the Danish fleet might have approached alarmingly near to Kiel without being molested. As commandant of Friedrichsort, he built the fortifications for the protection of the harbor of Eckernförde, which became very famous the next year in connection with the rout of the Danish squadron.

Siemens was next commissioned to lay an underground telegraph from Berlin to Frankfort-on-the-Main where the German National Assembly met. The transmission of the result of an election in the winter of 1879 to Berlin, within the hour, gave the line great repute, and Siemens was employed to construct another line from Berlin to Cologne and Verviers, on the Prussian frontier. In this enterprise he had the assistance of William Meyer, a man skilled in organization. Many difficulties incident to the imperfections of an art still in a crude condition are described as having been encountered in executing these works. The constructors were sorely embarrassed, in crossing the Elbe and the Rhine, to find means for protecting the wires against dragging by ships' anchors. The wire across the Rhine was inclosed in a wrought-iron tube so well that, when it was taken up several years afterward, a number of anchors were found hanging from

it which, having been caught in it, the shipmasters had been obliged to cast away. At Verviers the line was connected with an overhead line to Brussels. One Herr Reuter, who had been managing a carrier-pigeon post between Cologne and Brussels, found his business ruined by the telegraph. Frau Reuter complaining to Siemens of this, he advised the pair to go to London and establish there a telegraphic news agency, as Herr Wolff had succeeded in doing at Berlin. This was the origin of "Reuter's." These enterprises had been carried on under a furlough from army service, which was about to expire, and Herr Siemens, in order to devote himself to scientific and technical work, resigned his position in the army in June, 1849, left the telegraphic service shortly afterward, and began a career of independent scientific industry. His underground system was generally adopted in Germany. To prevent the depredations of rats on the gutta-percha coatings, he drew the wire through lead pipes. He recognized the excellences of the Morse telegraphic instrument, and sought to improve it. In April, 1850, he presented a memoir on his experiments in telegraphy—*Mémoire sur la Télégraphie Électrique*—before the French Academy of Sciences, and received, upon the report of the committee to which it was referred, the acknowledgment of the Academy, thus fixing the stamp of that authority upon his claims for originality and priority.

While Siemens's system was being extended and adopted in foreign countries, particularly in Russia, the Prussian lines, under official management, constructed in a slovenly manner and carelessly repaired, deteriorated. Siemens published a pamphlet criticising these faults and pointing out the remedies, in consequence of which unauthorized comment the Government discontinued all connection with his house for several years. The loss of this business was, however, more than compensated for by that which accrued from railroad telegraphy, still free from official domination, and by contracts coming in from abroad.

The connection of Siemens with the Russian telegraph lines began in 1849, when his instruments were adopted for the line between St. Petersburg and Moscow. In the winter of 1852 he went to Riga, on business connected with the construction of a line to that point, and particularly with the crossing of the Dwina. Other lines calling for visits to Russia, and in connection with which the St. Petersburg branch of the house of Siemens and Halske was built up, were those to Kronstadt—the first successful submarine cable line—and Warsaw. The success of the last line determined the Russian Government to cover the whole empire with a telegraphic network, and lines were built in succession from Moscow to Kiev, Kiev to Odessa, St. Petersburg to Revel, from Kovno to the Prussian borders, and from St. Peters-

burg to Helsingfors. Then the Crimean War came on, and the firm was kept busy with the special lines demanded for its prosecution.

After two failures by an English firm in trying to lay a telegraphic cable between the island of Sardinia and Bona in Algeria, the third attempt was successfully carried out in September, 1857, with material furnished by Herr Siemens's house and in a method prescribed by him. This was the first of the deep-sea cables, or of those which were laid in water more than one thousand fathoms deep, and was followed by the laying of many longer lines, in most of which enterprises Herr Siemens had a part. In 1859 he was shipwrecked on the Alma in the Red Sea; in 1863 he came very near losing his life while trying, with his brother Wilhelm, to lay the cable between Oran and Cartagena. The brothers laid the line from Malta to Alexandria, and, with the steamer Faraday, built especially for the purpose, they laid six transatlantic lines. In its attempts to maintain telegraphic communication with India the British Government had found its lines through the Mediterranean Sea, Asia Minor, and Persia too liable to interruption to be depended upon. To take the lines through safer regions they would have to be carried partly through Russian territory. Herr Siemens was applied to, and he, through the good will he had won by his constructions for the Russian Government, secured a concession from it for building a line through Kiev, Odessa, Kertch, and the Black Sea to Suchum Kale. The business of this line led him several times into the country of the Caucasus, concerning which and the prehistoric copper mines at Kedabeg and the German colony at Annenfeld in the same region he gives, in his Reminiscences, some very pleasant accounts.

As much as to his improvements in the electric telegraph, the practical applications of electricity owe to Siemens's invention of the dynamo-electric machine in the winter of 1866, which opened to them entirely new fields in the development of power and light. In claiming the credit due to himself in this field, he does not forget to acknowledge what he owes to the predecessors who laid the foundations on which he built.

While thus busy with the development and practical application of electrotechnics, as he called it, Siemens observed and participated in the advancement of other branches of science; and we find him now busy in investigating the geological structure of the earth; now engaged, with his brother Wilhelm, in researches concerning the cause of the sun's heat and the means by which it is maintained, or studying with his brother Friedrich new problems of heat; now plunged in the most abstruse problems of meteorology; now sharply criticising the bacillus theories of Dr.

Koch—all with the knowledge and consideration of one who had made deep studies of the subjects.

Dr. Siemens's literary efforts were limited, he tells us, chiefly to expositions of his scientific and technical labors and descriptions of his mechanical constructions. He had sometimes occasion to answer attacks upon his firm or upon himself personally. Besides those of which we have already spoken, he mentions as among his principal contributions to scientific literature a paper in Poggendorff's Annals, in 1857, on Electrostatic Induction and the Retardation of the Current in Conducting Wires; a communication made conjointly with his brother Wilhelm to the British Association in 1860 (Sketch of the Principles and of Practical Experience in the Testing of Submarine Telegraph Lines and their Conductivity); his lecture, in 1879, on Electricity in the Service of Life; and his address before the Society of German Naturalists and Physicians, in 1886, on The Scientific Age; papers On the Light of a Flame; On the Admissibility of the Conception of an Electric Sun-potential and its Significance in Explanation of Terrestrial Phenomena (called out by the discussion of his brother Wilhelm's paper, On the Conservation of the Solar Energy); Contributions to the Theory of Electromagnetism; On the Maintenance of Force in the Atmosphere of the Earth, 1881 and 1884; On the Question of Air Currents, 1887; On the General Wind System of the Earth, 1890; and On the Question of the Cause of Atmospheric Currents, 1891.

He elaborated the plans, and saw them adopted by the Prussian Government and Parliament, of the Physical-technical Imperial Institute at Charlottenburg for scientific research, of which Helmholtz is director. In 1874 he was made a member of the Royal Academy of Sciences of Berlin. He received the degree of Doctor of Philosophy, *honoris causa*, from the University of Berlin; was made a Knight of the Prussian Order for Merit; and received the patent of nobility in 1888. He was also a member of many learned societies.

M. J. Dybowski has transmitted to the French Academy of Sciences specimens of a condiment prepared by the peoples living on the banks of the Oubangui River, one of the affluents of the Congo. It is obtained by the incineration of river plants, and is composed chiefly of chloride and sulphate of potassium, with very little carbonate of potassium and no soda. This confirms former observations of the scarcity of soda in land plants. These usually contain considerable quantities of a very alkaline carbonate of potassium, not suitable as a condiment. The natives choose for incineration certain species containing only slight proportions of the carbonate. Although the salts of potash are considered unwholesome, these natives do not appear to suffer from using them.

EDITOR'S TABLE.

AIDS TO MISERY.

AN extremely instructive article appears in the Fortnightly Review for August, under the title of The Poor of the World. The author, Mr. Samuel A. Barnett, has been traveling round the world in order to inform himself by personal observation and inquiry as to the condition of the poor in different countries. The result, so far as presented in this article, is to show that everywhere the great underlying cause of poverty is lack of individuality and the power of self-help, and that the only ultimate remedy is the creation through education—understanding the word in its widest sense—of more perfect individuals. This is the doctrine which Mr. Spencer has been preaching directly and indirectly for many years past, often at the cost of much contumely and, in general, to unbelieving ears. The reason for the unpopularity of this view is not far to seek. Eager reformers do not like to think that the evils they combat are deep-seated and can only be slowly worked out of human nature; they cherish the hope of accomplishing great things in a short time and seeing the fruit of their labors in a striking form. Sentimental persons, again, always want to cast the blame of what is wrong on somebody; and if they can not see quite clearly who in particular is to blame, they denounce "society." It is pleasanter to feel ourselves fighting the selfish, the indifferent, the grasping, or those whom we are pleased to consider such, than to accept the position of simply trying to repair evils inherent in the condition of things as molded by natural forces. All within us that craves for the quick, the short, the easy, the sensational, indisposes us to accept a theory that opens up a vista of patient, prolonged, and carefully revised effort, bringing with it little of glory at any one time, and calling for the exercise of no small amount of scientific faith.

We have been hearing lately of the sanguinary conflicts of Hindus and Mohammedans in the streets of Bombay. Different as the creeds may be which the two races possess, Mr. Barnett found that the temples of the one and the mosques of the other were equally centers of distribution of a large amount of charity, the product of gifts gathered from the rich, and that the effects of this charity were most pernicious. "If ever," he says, "one is inclined to doubt the danger of priestcraft, a visit to India ought to dispel such doubts. He will find in the Brahmans a typical priesthood, and he will see how their unquestioned rule has degraded the people, until they seem without power of clear thinking or wide feeling." How charity serves the priesthood a double turn is well explained: "The pious give, not because their brothers have need, but to please the god; and it is nothing to them if their gifts are consumed by the priests or wasted on worthless objects. The priests give as priests—either to attract worshipers to their temple or to deliver their own souls." The charity thus dispensed, far from abating poverty increases and extends it. In Hyderabad, where the Mohammedans are in the ascendant, ten per cent of the revenue, in addition to large private gifts, is spent on keeping armies of beggars who are descendants of orthodox families, while it is quite a common thing for wills to provide for the feeding of idle multitudes on certain holy days of the year. In India, moreover, an obligation is laid upon all the members of a family to support one another. As a consequence, "the hard-

working and successful man is kept low by weak and very often idle relatives." The system, to quote Mr. Barnett again, "checks enterprise and tends to make a dead level of poverty in which there are no richer people to act as barriers against the flood of famine or bad times." One is sometimes touched, he confesses, by the way in which the strong hold on to the weak, but it is impossible not to notice that idlers abound. Nowhere is there so little individuality, nowhere such feebleness in prospect or in presence of calamity.

While family feeling is strong in India, the general feeling of humanity is weak. The reason, our author says, is "partly because the people think too much of their gods. . . . The chief duty of man seems to be to please his god; and when, by a gift, he has delivered himself of this duty, he thinks no more of his brother at the gate." Among such people the task of a government seeking to effect reforms becomes extremely difficult. "All measures," Mr. Barnett well observes, "must be ineffectual so long as the people themselves are deficient in life-preserving qualities, such as confidence, enterprise, and self-control." Here we have the gist of the whole matter. There are certain qualities, moral, intellectual, physical, which are *life-preserving*. They may be said to qualify for life; and when they are absent nothing but a constant strain upon better qualified individuals will enable the defective ones to survive. By "confidence," Mr. Barnett means in this place confidence in others, and he illustrates his remark by stating that, for want of confidence, any savings the poor can make in India "are not invested or even intrusted to a bank; they are turned into jewelry to burden the women's fingers, toes, noses, and ears, and at last sold to provide a marriage feast." He cites the fact that there are in India four hundred thousand jewelers and only three hundred thousand smiths. As a life-preserving quality, however, confidence in self is at least as important as confidence in others; and confidence in self, or, in other words, self-reliance, is just the quality at which so much of the charity of our day strikes. Charity is flowing in an ever-broadening stream; but it does not qualify for life those whom it enables to live; on the contrary, it saps what little energy they have, and so hands on a magnified problem to be dealt with by the charity of the future.

The inhabitants of India are said to be the most docile people in the world, but on that very account they are more difficult to govern, because their weakness makes them look to the Government for everything. As Mr. Barnett forcibly remarks, "It is perhaps more difficult to keep a weak man on his feet than to prevent a strong man from rising." If you have the strong man down you have gravitation in your favor; but in trying to keep the weak man up you have gravitation against you, and gravitation is apt to win in the long run. The Government of India, Mr. Barnett testifies, is doing a great deal of useful work in the promotion of industries, the improvement of the soil by irrigation, and the enforcement, as far as possible with such a population, of sanitary measures. But all this costs money, and as one thing leads to another, one abuse corrected revealing a dozen others that need correction, the expense of government and the burdens which the people have to bear in the way of taxation are constantly increasing. "Government," as Mr. Barnett puts it, "does much to relieve the people, but the conclusion of the whole matter leaves one doubtful if it would not be more helpful if it did less for them and took less from them." And he pithily adds, "A system undoubtedly good may be so costly as to be bad." Surely there is much in all this that we may reflect on with advantage here. The advantage of such a comparative study as Mr. Barnett is making is that it shows various evils in their fuller development, and puts com-

munities in which they may exist only in lesser degree on their guard.

Mr. Barnett has also made a few observations in this country. He found in San Francisco a form of government "so democratic as to leave hardly a grievance for the most ardent demagogue." And yet "the poor increase, and the talk is as the talk of East London about starvation cases and the inadequacy of the poorhouse; the demand is for laws to prevent vagrancy, to reduce rents and limit immigration." There is abundant charity; the officer of the Associated Charities, we are told, "confessed that it was impossible to control the impulses of the rich men of the city; and if he complained that gifts did mischief, the answer was, 'What is that to me?'"

In Boston there is a very perfect system for the organization of charity; but when Mr. Barnett inquired whether the clergy and philanthropic persons made use of the records kept in the central office, the answer was, "No." Here, as elsewhere, "private charity is wayward and willful; gifts go as passing emotion directs, institutions are created which represent the fancy rather than the sympathy of the creators." Then, when gifts are found to be of no avail, repressive legislation is resorted to—laws against drinking and even cigarette-smoking. The drink must be taken in a perpendicular position, and the cigarette must not be smoked by any person under a certain age. Mr. Barnett's article is good reading, and as a capital appendix to it we recommend the chapters on Negative and Positive Beneficence Mr. Spencer's last volume. The philosopher is justified by every wide and impartial survey of the facts.

THE AMERICAN ASSOCIATION MEETING AT MADISON.

Experience shows the American Association that it can have a large attendance at its meetings only by keeping to the main highways of travel, and by choosing large cities. With the World's Fair as a magnet, drawing and holding hundreds of its members, the association was fortunate in assembling as many as it did, some two hundred and ninety, at Madison. Those who attended were rewarded by good papers and stimulating discussions, and if the sectional meetings were smaller than usual, they were uncommonly earnest and interesting from the absence of the distractions not to be avoided when a multitude gathers together. Hospitality was hearty; the people of Madison—a city, by the way, of singular beauty—with the University of Wisconsin, renewed the best traditions of the Association in manifold opportunities for bringing old friends together, for presenting beginners in science to leaders grown gray in the service of truth.

In his opening remarks President William Harkness, of Washington, touched on a practice of the Academy of Sciences of France well worthy of imitation in America—the conferring membership upon those of its friends who, while not themselves men of science, provide financial aid for research. At Nice, for example, an observatory of world-wide repute has arisen as a gift of Mr. Bischoffsheim, a banker, whose name is rightfully enrolled beside those of the astronomers whose labors he has lightened and promoted.

Evolution was the keynote in the addresses of the vice-presidents in the Sections of Zoölogy, Botany, and Economics. Prof. H. F. Osborn, in sketching the Ascent of the Mammalia, traced the succession of typical species plainly derived one from another. Exploration within recent years, he said, has but served to confirm Prof. O. C. Marsh's demonstration of the horse's genealogy through forms with which Prof. Huxley in his American lectures has made the world familiar.

Prof. Charles E. Bessey, in his address on Evolution and Classification,

said that for nearly forty years the system of Linnæus stood in the way of the better system of Jussieu and De Candolle; that system in its turn has for a third of a century been a clog and a hindrance to the adoption of the vivifying idea that genetic ties are the true basis for classification. The botanist in giving this new and illuminating order to plants must be careful to discriminate between primitively simple forms and those simple by derivation. Parasites are far from being the only plants that have undergone simplification of structure; in willows and poplars, for example, a single ovary has resulted from the union of two or three ovaries. For flowering plants Prof. Bessey presented in detail a revised arrangement of the Benthamian series.

The Mutual Relations of Science and Stock-breeding gave Prof. W. H. Brewer, in his address to the Economic Section, an opportunity of showing how an art is broadened and bettered when it flowers into a science. Until Darwin's Origin of Species was published stock-breeding followed the rule of thumb, with results slow and uncertain; to-day, when heredity is understood as due to influences largely calculable and controllable, stock-breeding almost rises to the assuredness of a plastic art. Prof. Brewer spoke of a sheep-breeder of his acquaintance who has all the ideality of the true artist, who figures to himself a perfect sheep with every good point at its best, every defect eliminated; in striving to give substance to that form as he imagines it, this man is as devoted as any wielder of chisel or brush. Breeding, said Prof. Brewer, can alone decide whether acquired characteristics are transmitted, and it may even throw an important side light on vexed questions of education.

Prof. E. L. Nichols, in his address to the physicists on Phenomena of the Time Infinitesimal, showed a bullet in flight photographed in an interval so brief that the missile seemed at rest. In another picture the bullet was shown in the act of shattering a pane of glass, with all the incidental perturbation of the surrounding air. In giving rapid motion to the sensitive plate Prof. Nichols pointed out how its availability can be vastly extended. In this field, he maintained, there is abundant harvest for the investigator, for when the time interval is appreciable we do not get a picture really instantaneous, but only a composite photograph whose elements we have to guess at. As to what happens in the first hundredths of a second in the polarization of the voltaic cell, in electrolysis, nothing is known, and here possibilities of the highest interest await the suitable application of the camera.

In reviewing twenty-five years' progress in analytical chemistry Prof. Edward Hart brought out its remarkable stimulus from the exigencies of industry, and the no less remarkable fashion in which the debt had been repaid. In 1868 the determination of phosphorus in steel required two to three days; to-day twelve minutes suffice. At the furnaces of South Bethlehem, Pa., a sample of molten metal is passed upon by the analyst while the iron is still on its way to the converter; the manufacture can thus be intelligently directed with the utmost promptness. This is but one of the important ways in which the chemist has borne a part in cheapening iron and steel. The work of analysis, in this and other departments, has been greatly quickened by developing those methods which allow the chemist to determine in a single specimen one constituent rapidly and accurately. It is preferable to determine phosphorus in one sample and sulphur in another than to determine each separately in the same sample. In closing his review Prof. Hart mentioned the honored chemists of America who have notably contributed to the world's advance in their science during the past quarter of a century—men little known to a nation richer, longer lived, and happier because of their

unselfish labor. Prof. S. W. Robinson, addressing the Mechanical Section on the education of the engineer, made incidental reference to invention as an aim in class work. Admitting that ingenuity of the highest order rests upon an incommunicable somewhat, he argued that inventiveness of a valuable kind was quite within the scope of teaching. In the department of machine design he believed lay a field for eliciting the originality of students; the several parts of a machine could be studied with a view to their improvement, and then the machine as a whole could be redesigned. Time was when it was considered artistic to give a machine or engineering structure the outlines of the Greek orders; to-day a design which is seen to be strong, rigid, and economical is found to lend itself to a beauty of form impossible to borrowed lines, however graceful in themselves.

Prof. C. A. Walcott, in his discourse on geological time as indicated by the sedimentary rocks of North America, prepared the hearer for the address of Prof. Joseph Le Conte, as retiring president, on the origin of mountain ranges. This address in matter and spirit was a master's lesson in scientific method. Without the waste of a word Prof. Le Conte lucidly explained the theory of mountain birth which science owes to him and to Prof. J. D. Dana. That sea margins have everywhere been the seat of mountain emergence was declared to be a fact of observation; that the physical cause for this fact is mainly the shrinking of a cooling and practically viscous planet, seeking equilibrium, was argued with a judicious weighing of the objections urged by T. Mellard Reade and other critics. For all the natural affection that a thinker must bear the child of his brain, Prof. Le Conte claimed no more than that the probabilities were in its favor, leaving the last and unappealable verdict to be uttered only when all the evidence has been discovered and passed upon. Contrasted with the scientific erudition of this address was Dr. D. G. Brinton's popular introduction to The Earliest Men on the following evening at the public session. Choosing apt and simple illustrations, he showed how the anthropologist, from remains which seem rather scanty, is able to piece together a picture of primitive men. That they had compassion and skill enough among them to nurse the helpless for months together was, for example, proved by adducing the bones of a man who had suffered a compound, comminuted fracture, and survived the misfortune several years.

One of the liveliest sectional discussions arose among the botanists on the reading of Prof. C. R. Barnes's paper on The Food of Green Plants, in which paper it was maintained that the protoplasm of plants and animals is identical. Prof. N. L. Britton could not see how the profound divergences between animals and plants, in their highest forms, could have arisen, except through elemental differences in protoplasm. Prof. C. MacMillan also demurred to the dictum of Prof. Barnes: animals are analytic, energy-producing; plants are synthetic, energy-absorbing; that plants have a certain superiority over animals comes out, he argued, in their comparative superabundance. In this section Prof. C. MacMillan also read a brief paper, proving how seriously botany is neglected as a study in American colleges and universities, many biological laboratories being devoted chiefly to instruction in zoölogy. The section voted that through the proper official channels the Department of Agriculture, at Washington, be requested to print and circulate Prof. MacMillan's paper.

To the chemists Prof. E. W. Morley detailed the refined methods by which he assigns to oxygen a specific gravity of 15·882, as a result of twenty recent determinations. An apparatus for ascertaining expansions was exhibited by Prof. Morley, its inventor, and Prof.

W. A. Rogers, its builder, with which a millionth of an inch can be easily measured, and with careful adjustment even one twenty-millionth of an inch. In principle the apparatus is an application of Prof. A. A. Michelson's interferential refractometer, the interference of light-waves from mirrors attached to a standard and to a compared metallic bar enabling the observer to determine minute movements with a precision hitherto impossible.

An inquiry into the properties of paraldehyde and metaldehyde by Profs. W. R. Orndorff and John White illustrated the inferences whereby the chemist is able to body forth the respective positions in a molecule of the atoms which compose it. In the Anthropological Section the songs of sequence of the Navajoes were rendered by a phonograph, an instrument which promises to be as indispensable as the camera to the serious traveler. A discussion of the most animated kind took place in this section between Rev. G. F. Wright and Mr. W J McGee on certain evidences adduced by the former of preglacial man, Mr. McGee maintaining that the evidence was merely probable and not conclusive.

OUR NEW INDEX.

HALF a century ago science was an affair of a few individuals, and a laboratory of any kind was to most people only a curiosity. The man who devoted himself to the study of Nature was looked upon as a visionary having neither place nor function among the contributors to human welfare; scientific methods in the arts were rarely heard of; natural knowledge had no part or place in education; and, besides an occasional learned treatise, two or three technical periodicals met all the needs of scientific publication.

But all this has now been changed. The last half of the nineteenth century will long be memorable as the period during which science achieved a prominent if not a leading place in nearly every department of human activity. The wonderful advance of discovery, closely followed as it has been by numerous practical applications, has wrought a revolution in many fields, until in the arts, in commerce, in education, and even in the professions, science may justly claim to exercise a controlling influence.

With all this there has come an enormous increase in the volume of scientific literature. Scores of scientific periodicals are engaged in the work of disseminating the results of investigation and books by the hundred are published every year in which the methods and conclusions of science are given more permanent record. The accumulation of material from this ceaseless and ever-increasing activity is already so great that ready means of access to it becomes an urgent need of the hour.

But it is only with a subdivision of this great body of knowledge that we are here specially concerned. In the early days of the scientific awakening just alluded to, it was only natural that the results obtained by workers in science should for the most part remain the possession of the student and investigator. That science, however, had a message for the people was not long in being perceived. Side by side with its many important industrial applications there had grown up a vast body of scientific knowledge only needing suitable interpretation to make it available for the masses. Under the stimulus supplied by a few enthusiastic public teachers there gradually arose a demand for this new kind of knowledge that would brook no refusal. In obedience to this desire of the public we have seen issuing from the press during the last twenty-five or thirty years a steadily growing stream of popular scientific literature embodying the ablest thought of the time, and much of it the direct product of our most distinguished scientific men.

To this class of literature THE POPULAR SCIENCE MONTHLY belongs. Its special work has been to spread current scientific thought in simplified form among the people, and we may confidently claim that in no other publication can there be found a more useful, more complete, or more interesting record of the science of the last twenty years available for the general reader than is contained in the forty volumes to which our new Index is intended as the key.

To place this great store of information at the command of the intelligent reader so that he may inform himself on any given subject with the least outlay of time and attention this Index has been planned and compiled. It groups the articles so that any one looking up, for instance, Anthropology, Evolution, Manual Training, Social Science, Vivisection, can find what has appeared in the MONTHLY on the subject in question under that head. Practical usefulness has been put before mere logical accuracy in classification. As the MONTHLY is a popular magazine, popular names have been preferred to technical ones as names of classes. Thus, articles about Consumption are put under that head with a cross-reference from Tuberculosis. Cross-references from other synonyms have been liberally used.

Large aggregations of titles have been avoided by dividing subjects. Any one wishing to know what the magazine has contained on the question "Are the Planets inhabited?" would be more likely to look under planets than under astronomy; accordingly, all articles dealing exclusively with the planets, sun, moon, stars, or nebulæ are put under those respective heads, with a cross-reference under astronomy.

This Index contains a new feature that must prove of great value to users —that is, it gives the number of pages and illustrations in each article in its subject entry. By this means the searcher can see which are the most extended and instructive articles in a long list.

The titles of all books noticed in the MONTHLY have been entered under the subjects of which they treat, these entries being distinguished from the titles of articles by Italics. As all important books of a popular scientific character published in the past twenty years have been sent to this magazine for review, a valuable classified bibliography of popular science for that period is thus furnished.

Having adopted a new plan for the present volume, we have thought best to include in it the whole contents of the magazine from its first number. The Index of Volumes I to XX is thus superseded.

To any one who has a file of the MONTHLY from the beginning, this Index will be like a key to a treasure house. To any one who has not a file, but who depends upon a public library for the use of the volumes when he has occasion to read up a scientific subject, the Index will be an even more valuable possession, for it will enable him to call for the volumes he wants without loss of time.

Finally, we wish to recognize the ability of the compiler, Mr. F. A. Fernald, who, bringing to the work a large experience in indexing, has exercised the utmost care to secure accuracy and completeness, and has also suggested and carried out several improvements that will add greatly to the convenience of readers.

LITERARY NOTICES.

HYPNOTISM, MESMERISM, AND THE NEW WITCHCRAFT. By ERNEST HART, formerly Surgeon to the West London Hospital. With Twenty Illustrations. New York: D. Appleton & Co., 1893.

THIS little volume consists of papers that have recently appeared in the Nineteenth Century and the British Medical Journal, and it has been published to meet the wishes of those desiring the latest informa-

tion on topics that are of current interest. Mr. Hart frankly states that he hopes the volume will serve a useful purpose in dissipating some popular errors and a good deal of pseudo-scientific superstition, superimposed on a slender basis of physiological and pathological phenomena.

His first chapter has the suggestive title of Hypnotism and Humbug, and in it he refers to the fact that hypnotism has come down to us through the ages, the lineal descendant of many ancient beliefs. He very truly says that the term "animal magnetism" applied to any of the phenomena of induced sleep, human automatism, hypnotic suggestions, or faith cures is a pure misnomer, being an example of that tendency satirized by Voltaire when he speaks of the custom of "mystics and charlatans to consecrate their ignorance and to impress its conclusions upon others *by giving a name that has no meaning to phenomena that they do not understand.*" Briefly and lucidly the physiological explanation of that more or less complete suspension of the will, known as induced sleep, is portrayed; and reference is made to the various phenomena that may be displayed by an individual under the influence of suggestion. But Mr. Hart emphasizes the fact that the allegation that an individual under the influence of suggestion has powers of clairvoyance, can predict future events, has insight into hidden things, or, in a few words, has developed new powers, is, under any and all circumstances, imposture.

The second chapter briefly refers to the ancient employment of the magnet in medicine, to Mesmer and his methods, to the "possessed" and the "demoniacs," and Mr. Hart shows that all these influences are the result of a condition of disturbed equilibrium of the nervous system and brain apparatus of the person operated on or affected therewith. A number of illustrations of postures and facial expressions of patients in the Salpêtrière Hospital in Paris are inserted and lend force to the author's thesis that most of the phenomena characteristic of the extreme degrees of hypnotization and suggestibility may occur in that condition of disturbed equilibrium of the patient, male or female, known as hysteria. In the latter condition there is often an auto-suggestion that, like the hetero-suggestion inducing hypnotism, abolishes the power of the will; and the brain losing its restraining and controlling powers, emotions may be excited, feelings induced, and intellectual operations set in motion, independently of the will of the individual as well as without individual consciousness being alive to what is going on. As to the treatment of disease by means of what has been termed "suggestive therapeutics," Mr. Hart cites Charcot, Ricker, Babinski, and Déjerine, who agree that for curative purposes hypnotism is very rarely useful, generally entirely useless, and often injurious.

The third chapter is one of the most interesting in the volume, dealing as it does with Luys's experiments at La Charité Hospital in Paris, that have been given wide publicity in general literature and that have served to originate many misconceptions regarding the phenomena of hypnotism.

Dr. Luys defines hypnotism as an extra-physiological experimental state of the nervous system, or a pseudo-sleep which is imposed and during which the subject under experiment loses the notion of his or her own existence and of the external world. He professes to create experimentally many of the disorders of mental pathology in certain stages of hypnotism, and thus to give a factitious representation of some of the disorders of madness. He presented for Mr. Hart's observation five patients that were, Mr. Hart states, profoundly neuropathic. These patients were extremely sensitive, when hypnotized, to feeble magnetic currents, to residual magnetic impressions, to magnetic effluvia, to the perception of colored luminous atmospheres radiating from and playing around the poles of a magnet or of a faradaic machine, and to flames and effluvia of like character proceeding from the features, the fingers, and the hands of the human subject. These subjects would caress with various manifestations of delight the "north pole" of the magnet, about which they saw blue flames playing, while dread and terror were produced by presenting the "south pole," about which red flames played. Even photograph paper having an impression of the "north" or "south" pole produced similar phenomena in these persons. Around the head of one of the hypnotized persons a

circlet of magnetized iron was placed that had been around the head of a person subject to hallucinations of persecution and of black misery; the patient's features became haggard, his expression melancholic, and he struggled, with evident horror and fright, to escape from imaginary persecutors; the removal of the circlet restored him to calmness. These ideas had remained stored in the circlet, as Dr. Luys informed his audience, for six months, and were apparently by no means exhausted notwithstanding frequent use. Small sealed tubes containing various medicinal substances applied to the necks of these hypnotized individuals produced symptoms similar to those caused by the administration of the substances internally. Another series of phenomena was produced by having the hypnotized person hold a glass of water or a wax doll in the hands, and their sensation was transferred to the object held so that if the glass of water or the doll was stroked, pinched, pricked, or tortured at a distance, and presumably where the subject could not see what was done, the sensation was transferred from the object to the person, who would express emotions conforming to what was done to the supposed sensitized object.

Mr. Hart found that Dr. Luys was unwilling to allow him to make certain tests that would control these experiments and determine whether the "subject" was dissembling or unconscious. Accordingly, he made arrangements to have Dr. Luys's "subjects" come to his chambers, where he had a nonmagnetic bar resembling the magnetized bar that Luys had used, a demagnetized magnet, a set of needles variously and inversely magnetized, sealed tubes containing the medicinal substances used by Luys as well as some containing water, two similar glasses of water and two similar wax dolls. In the presence of a number of credible witnesses he repeated Luys's experiments, and the "subjects" were delighted with the north pole, although there was no current turned on, and false phenomena were obtained with all the magnets employed. The doll or glass of water to which sensation had been transferred from a "subject" was surreptitiously exchanged for the unsensitized glass of water or doll, but that made no difference in the phenomena elicited by the stroking, pinching, etc. The sealed glass tubes containing water produced the tipsy scenes that arose when Luys applied to the neck the tube containing brandy, while one containing the latter produced any symptom that was expected to be obtained from whatever substance was mentioned. In other words the "subjects" were artful and efficient impostors and Dr. Luys was their dupe, as one of the "subjects" herself stated.

We believe that this brief review of the scope of the experiments justifies Mr. Hart's assertion that Luys's experiments were conducted with culpable looseness in his methods, and that there were incredible extravagance and error in the deductions that he allowed himself to make from the false phenomena to which his mode of experimentation inevitably led.

Mr. Hart believes that the alleged advantages of the therapeutic employment of hypnotism in certain neuroses, in alcoholism, and in the cases of backward or naughty children, are untenable, and that the effect of its employment is to weaken the will power that it is desirable to strengthen. In fact, compared with the hypnotist faith-curer of the hospital ward, the balance is in favor of the faith-curer of the chapel and the grotto. The latter strengthens the weaker individuality by playing upon the theme of auto-suggestion; the patient is told to believe that he will be cured, to wish it fervently and he shall be cured. And his cure is quite as real and likely to be quite as lasting as if he had become the puppet of a hypnotizer.

The method in which the subject is presented serves to convince the reader that the phenomena of hypnotism do not transcend the confines of explicable fact, and that those that believe that it contains much that is occult are but the dupes of their own credulity. The volume is written in a style that will enable the lay reader to understand the topic, and it is to be hoped that its wide circulation will correct many of the popular impressions regarding the possibilities as well as the facts of hypnotism.

ELECTRICAL EXPERIMENTS. By G. E. BONNEY. London: Whittaker & Co. Pp. 252. Price, 75 cents.

THIS book has been prepared, Mr. Bonney informs us in his preface, for the in-

structive amusement of young people in the country whose time hangs heavily on their hands in the winter evenings. It consists of a collection of simple experiments in magnetism and electricity, requiring only such apparatus as the experimenters can construct for themselves. The first class of experiments described are with permanent magnets. These are followed with a number of experiments with electro-magnets. A chapter is devoted to experiments with induction coils, in which various forms of Geissler tubes are shown and described. Most of the simpler experiments with static electricity commonly described in the text-books are given in the chapter devoted to this form of electricity, and the electrolysis of water and other liquids and the method of electro-plating in that on electrolytic experiments. Some miscellaneous experiments in thermo-electricity and with the electric light complete the book. The experiments are, on the whole, well selected to illustrate the characteristic phenomena, and are clearly described in simple terms suitable to the audience to whom the book is addressed.

HOW TO MAKE INVENTIONS, OR INVENTING AS A SCIENCE AND AN ART. By EDWARD P. THOMPSON, M. E. Second edition, revised and enlarged. New York: D. Van Nostrand Co. Pp. 181. Price, $1.

IN his preface Mr. Thompson says that his object is "to establish inventing as a science." In the first chapter he advances excellent reasons for his claim that this may be done, but he does not carry out his reasoning logically. For instance, in the fourteenth chapter the author says that although "Coster was the first to conceive the idea of replacing handwriting by printing," his discovery was "knowledge, not an invention." Science is knowledge, and the application of it to a hitherto unknown art surely might be construed an invention. Nevertheless, Mr. Thompson has given to the world in this book a fund of useful and interesting information which can not fail to be of benefit. It contains some very excellent advice to those who "have ideas," and if only his suggestions were adopted many a tyro inventor would be saved a good deal of both worry and useless expense.

The chapter entitled Suggestive Ideas is full of valuable promptings and advice. So is Chapter VII. In the latter the author lays down four rules which should be observed by inventors. The first rule says, "Do not begin with intricate problems." The others warn inventors against confining themselves to single devices, and exhorts them to "practice medium problems," and study the analysis of the methods by which they desire to accomplish new results.

In the chapters on Principles in Chemistry and Electricity "for making scientific inventions" Mr. Thompson has treated the probabilities of invention with the assistance of these great factors, besides giving a large fund of useful information regarding these elements in the field of invention. The major part of the volume treats of the possibilities of invention in the field of electricity, and consists for the most part of selections from the author's writings upon this subject in the Electrical Engineer and other scientific journals.

MECHANICS AND HYDROSTATICS. By S. L. LONEY. Cambridge: University Press. 1893. Pp. 304. Price, $1.25.

PROF. LONEY has prepared this little manual for the use of beginners, and presumes on only a limited mathematical knowledge by the pupil. The subject-matter comprises statics, dynamics, and hydrostatics, which are treated briefly and concisely, the propositions being illustrated by appropriate examples. A number of selected problems are appended to each chapter for the student to work out, the answers to which are given at the end of the book. In an appendix a sufficient exposition of elementary trigonometry is given to enable the student to follow the text when the mathematical treatment calls for more mathematical knowledge than elementary geometry and algebra.

THE MINERAL INDUSTRY: ITS STATISTICS, TECHNOLOGY, AND TRADE, IN THE UNITED STATES AND OTHER COUNTRIES, FROM THE EARLIEST TIMES TO THE END OF 1892. Vol. I. Edited by RICHARD P. ROTHWELL. Pp. 628. New York: Scientific Publishing Co., 1893.

THIS volume is a compilation of statistics, essays, and general information concerning the mineral industries of the United States and of the world, which will be gladly wel-

comed by all persons interested in the mineral resources of this country.

It is the most comprehensive work of this nature which has ever been put before the public. All puzzling measurements of quantity, etc., are reduced to the metric system, and the student can readily examine the progress of the different industries, from their earliest conception to the present time. The articles on aluminum, tin, chronology of the gold and silver industries, and the platinum group of metals are very important additions to the exhaustive statistical body of the work. The histories of the progress of metallurgy, assaying, etc., are also ably treated; and in the various papers on copper we have a perfect encyclopædia of the history, progress, values, and modes of producing this metal, which can not fail to be of great benefit to everybody interested in industrial progress.

Considering the ambitious plan of the compilation it is somewhat unfortunate that provision was not made for articles upon the *uses* of the precious and other metals, with a few tables showing their quantitative applications. Iron, lead, and nickel occupy a considerable portion of the work, and a wonderful amount of information can be learned about these metals and the progress of their production from the exhaustive tables that accompany the text. The onyx industry is rather summarily treated; but it appears that a difficulty existed in obtaining sufficient important data to make that article more interesting. Mr. Rothwell is to be congratulated upon the very useful volume which he and his assistants, Messrs. Benedict, Ingalls, Church, Hofman, etc., have produced.

OLD AND NEW ASTRONOMY. By RICHARD A. PROCTOR, completed by A. COWPER RANYARD. London and New York: Longmans, Green & Co. Pp. 816. Price, $12.

AT the time of the author's death, in 1888, about half of this volume had been published in parts, and about one third more was written, though incompletely. Mr. Proctor intended it to be the great work of his life, and to this end had been collecting material for more than twenty years before he began its publication. The chapters which he left in manuscript have been completed by Mr. A. Cowper Ranyard, Mr. Proctor's successor as editor of Knowledge, who has also written the part on the stars needed to fill out the plan of the work. As implied in its title, "Old and New," this treatise essays to give the notions of ancient astronomers as well as the present state of the science. The author has made a practice also of telling when, where, and by whom important discoveries and advances in our knowledge of the heavens have been made, and in this way has added much of the charm of narrative to his book. The large type, many illustrations and maps, and fine paper also contribute to make the volume an attractive one. The frontispiece consists of three views of pyramids, and in the first chapter, devoted to Ancient and Modern Methods of Observing the Heavenly Bodies, the use of the pyramids and other structures of masonry for this purpose is explained. In the same chapter are described the quadrants and astrolabes of the middle ages, and the most modern transit and equatorial instruments as well. The shape of the earth is the first subject taken up after the description of instruments. Under this head the various proofs that the earth is round are given, and the processes employed for measuring its curve are set forth. The third chapter is devoted to Apparent Motions of the Sun, Moon, and Planets, and is copiously illustrated with charts and diagrams. The author next describes the True Mechanism of the Solar System, and here has occasion to dip quite deeply into history in order to give the successive approximations to the truth arrived at by the early astronomers. He follows this account with a statement of the methods that have been devised for measuring and weighing the solar system. The sun, the moon, and each of the planets are fully described, a notably interesting chapter being made on sun-spots and solar prominences under the title The Sun's Surroundings. When his labors were broken off by his unexpected death Mr. Proctor had written nothing on the stars, the nebulæ, or the Milky Way, though it was known that he intended to make these sections a special feature of the book. It was in this department of astronomy that his own work was of most original and lasting character. Mr. Ranyard has sought to follow out the author's general

plan in the stellar section of this treatise by giving as complete a review as he could of the various theories which have been advocated with regard to the Milky Way and the distribution of stars and nebulæ. A feature of the book is the explanatory notes at the foot of nearly every page, and in these notes, throughout Mr. Proctor's chapters, are often to be found vigorous criticisms of words, things, and men which are notably characteristic of the author. The volume is indexed, and the illustrations comprise 31 plates and 472 wood-cuts.

HANDBOOK OF GREEK AND LATIN PALÆOGRAPHY. By EDWARD MAUNDE THOMPSON, D. C. L., etc. The International Scientific Series, Vol. LXX. New York: D. Appleton & Co. Pp. 343. Price, $1.75.

THE general reader will begin to have some fellow-feeling with the delver among ancient manuscripts after he has read this book, and learned something about the materials and implements used by scribes of different periods, the successive changes in the forms of the alphabetic characters, the various styles of handwriting characterizing different times and localities, and the numerous other features that aid in deciphering, and in deciding as to the age and genuineness of a given document. The author describes the Greek and the Latin alphabets, and gives charts showing the forms of script letters at different periods, and how the Latin alphabet was derived from the Egyptian hieroglyphs, through the hieratic, the Phœnician, and the Greek. Among the materials used to receive writing he enumerates leaves, bark, linen, clay, metals, both plain and waxed wooden tablets, papyrus, skins, parchment, vellum, and finally paper. The letters were scratched on waxen tablets with a sharp-pointed stylus; on papyrus they were traced in ink with a reed. The old form of a book was the roll. After the practice of hinging two or more tablets together in a "codex" arose, vellum books took on this more convenient shape. The further transition to the modern bound volume was easy. Naturally the ancient scribes sought to diminish their toil by abbreviations and contractions of words. These abbreviations form one of the chief difficulties that a person meets with when he begins to read Latin and Greek manuscripts, and a large number of them are explained by Mr. Thompson. In describing the several styles of Greek writing Mr. Thompson divides manuscripts written on papyrus from those on vellum. He considers first the book hand on papyrus, next the cursive hand on the same material, then the uncial hand on vellum, and lastly the mediæval minuscule writing. A similar course is taken in tracing the history of Latin palæography: The two branches of majuscule writing—capitals and uncials—form the first division, then come the modified uncial, mixed hands, and the half-uncial. Roman cursive writing is next taken up, descriptions of the national minuscule hands derived from it follow, and the history is brought down to include English charter hands of the fifteenth and sixteenth centuries. In these chapters, which constitute two thirds of the work, is seen a striking instance of the aid which physical science is giving to all branches of research and endeavor. Photographic engraving, by means of which the author puts before his readers actual facsimiles of a large number of styles of ancient writing, alone makes possible a really instructive book on this subject at a moderate price. These facsimiles enable us to compare, side by side, specimens from manuscripts which lie scattered in the different libraries of Europe, and which could never have been brought together. The volume has an index, and a list of the principal palæographical works used or referred to by the author is appended.

POOLE BROTHERS' CELESTIAL PLANISPHERE. Drawn and compiled by JULES A. COLAS. Price, $3.—POOLE BROTHERS' CELESTIAL HANDBOOK. Compiled and edited by JULES A. COLAS. Pp. xiv + 110. Price, $2. Chicago: Poole Brothers.

THE planisphere published by Messrs. Poole Brothers consists of the usual map of the constellations on a disk nineteen inches and a half in diameter, revolving under a screen. A skeleton screen is used, so that besides the constellations visible in the sky nearly all the others on the map can be seen. Disk and screen are mounted on a heavy sheet of cardboard, which slips into a substantial cardboard case.

The Celestial Handbook is intended as a companion to the planisphere, and has been compiled especially for the use of amateurs

in the study of astronomy. An introduction containing explanations and definitions is followed by systematically arranged data concerning the constellations. The data are accompanied by diagrams and illustrations, and consist of a short history of each constellation, a catalogue of the stars, with their designations, magnitudes, and positions, and notes on the principal curiosities contained in the constellations. Following this portion of the book are tables of old and new constellations, names given to the principal stars, etc. There are also brief chapters on shooting stars, star showers, comets, and the planets. The text is illustrated with one hundred and forty cuts.

SOME HINTS ON LEARNING TO DRAW. By G. W. CALDWELL HUTCHINSON. London and New York: Macmillan & Co. Pp. 199. Price, $2.25.

THE first "hints" given in this book relate to the reasons why drawing is an art that every one should desire to be acquainted with. There is the story of James Nasmyth, who, being in Sweden, where the party of either side could not understand the language of the other, secured a good supper by drawing its principal features, and got his other wants satisfied in a like way, with great admiration on the part of his hosts. The "graphic" language is thus evidently a universal one. Drawing is of first importance to architects, in teaching them to see artistically, without which they can not build artistically. It is a momentous aid in the cultivation of the observing powers, and "practically the first step in drawing is to learn to see accurately." One of the earliest lessons to be learned is "how very untrustworthy is the testimony of the untrained eyesight; when this is realized, the importance of keen observation becomes apparent." Erroneous conceptions, which are among the great difficulties in the way of good drawing, must be got rid of, for which purpose the student should be placed face to face with the object as soon as possible. Care should be taken to have the best specimens of the model obtainable. Freehand outline copies from the flat may, with advantage, be alternated every now and then with outline drawings from objects, so that we, by seeing and working from good copies, may have a high standard before us to show what our own work should be like. From the drawing of such common objects we may pass to outline drawings from casts of leaves or fruit, and thence to outlines from natural leaves and growing plants and shells, and casts from the antique. The time is not wasted that is spent in striving to do everything as thoroughly as possible, even the smallest thing. It follows from any fair consideration of the subject that there is no simple road, no one process or rule by which success may be obtained in drawing. Another important reason why every one should learn to draw and so learn to see, is in order that our taste for what is really good may be improved. The student is led from the opening story and these interesting considerations to the practical maxims and their application, which are given in a plain style, and are illustrated by numerous diagrams and by drawings from a group of living artists of the first rank.

REPORT OF THE UNITED STATES NATIONAL MUSEUM. For the Year ending June 30, 1891. Washington: Government Printing Office. Pp. 869.

THE catalogued collections in the museum now number 3,028,714 specimens, having increased about nineteen fold during the past ten years. It is observed, however, that a large portion of the material catalogued in 1884 and in later years has been in the custody of the Smithsonian Institution for several years, but in storage. There are now thirty-three organized departments and sections in the museum, under the care of curators, including honorary and acting curators and assistant curators. In the division of anthropology progress in the ethnological department has been satisfactory; the collection in prehistoric anthropology has been reclassified and rearranged according to locality, and special researches have been pursued in many directions. In forestry a systematic display of the more important lumber trees by means of maps showing their distribution, photographs of typical trees, and photomicrographs, has been begun. The zoölogical, botanical, mineralogical, and geological collections have been increased in nearly every department. The largest gift to the library during the year was from the Rev. John Crumbie Brown, of Scotland, of

the professional library of his brother, the late Dr. Samuel Brown, who has been called "the last of the alchemists," from his advocacy of a belief in the transmutability of the elements. The work of issuing the publications is now more punctually performed than heretofore. One of the aims of the museum —to aid students and others engaged in scientific work by lending them material to be used in their researches—has been carried out in a number of loans; and other students have availed themselves of the privilege of examining the collections. A summary is given in the report of the cases of co-operation with the work of the museum by various departments and bureaus of the Government, from which many valuable results have accrued. The papers contributed by members of the museum staff describing and illustrating the collections include The Genesis of the National Museum, by G. Brown Goode; Ethnological Collections in the United States National Museum from Kilimandjaro, East Africa, by Dr. W. L. Abbott; The Bernadon, Allen, and Jouy Korean Collections in the United States National Museum, by Walter Hough; Shinto, or the Mythology of the Japanese, The Ancient Burial Mounds of Japan, and Some Ancient Relics in Japan, by Romyn Hitchcock; Prehistoric Naval Architecture of the North of Europe, by George H. Boehmer; and First Draft of a System of Classification for the World's Columbian Exposition, by G. Brown Goode.

LECTURES ON SANITARY LAW. By A. WYNTER BLYTH. New York: Macmillan & Co. Pp. 287. Price, $2.50.

THESE twelve lectures were delivered by the author at the College of State Medicine, as part of the usual course of instruction in sanitary science. They are republished on account of their possible value to those who desire to obtain, in a small compass, a general view of the powers and duties of (English) local authorities in relation to the public health. Having described the division into sanitary districts and the functions of authorities, the lectures concern Nuisance; Sewerage and Drainage; Water; Sanitary Appliances, Regulations, and By-laws; Statutory Provisions with Regard to the Prevention of Disease; the Law under the Infectious Diseases Notification and Prevention Acts; Port Sanitary Law; the Housing of the Working Classes Act, 1890; Canal Boats and Metropolitan Sanitary Law. In the appendix are given examples of by-laws relating to offensive trades, with other matters, and the statutes specially treating of the inspection and examination of food.

The eighth volume of the *Mineral Resources of the United States*, compiled by *David T. Day*, Chief of the Division of Mining Statistics and Technology, contains 630 pages of statistical data relative to the progress made from year to year in the production of minerals. A complete statement of the mineral products of 1891, with comparative tables, occupies the greater portion of the volume, the remainder being devoted to a very important examination of the new discoveries of mineral deposits and explanations of improved technical processes by which minerals have been made more available and the yield increased, etc. The summary shows an increase in value in the entire mineral products of $9,501,139 over 1890, chiefly in silver, copper, lead, and coal, the iron and steel production having fallen off nearly one million tons in 1891. Washington, 1893.

In Bulletin No. 3 of the United States Department of Agriculture, 1893, *A. K. Fisher*, M. D., Assistant Ornithologist, contributes an interesting report upon the *Hawks and Owls of the United States*. From an examination of seventy-three species and subspecies of these birds, Dr. Fisher has arrived at the conclusion that instead of their being pests or enemies, all except six species of the hawks and owls of this country are really among the farmer's best friends. This conclusion was arrived at after an examination of the stomachs of 2,700 of these birds, when it was found that the principal food of sixty-seven of the species examined, comprising 2,212 birds, consisted of "mice and other small mammals" which are a constant source of annoyance and loss to the farmer. The work, which is illustrated with twenty-six colored plates, is a valuable contribution to the natural history literature of the country, and can not fail to be widely appreciated by ornithologists and lovers of the feathered tribe. The color, food, locality, and habits of each of the seventy-three species are de-

scribed. Pp. 210. Department of Agriculture, Washington.

Mr. *Marsden Manson*, C. E., has published an interesting little book entitled *Geological and Solar Climates, their Causes and Variations.* In it he attacks the published opinions of some of the most eminent students and writers of geology, and, although he admits that the direct cause of the Glacial epoch or Ice age was a decrease in the original heat of the globe, he scores those scientists whose researches established that fact because they failed "to account for all the phenomena accompanying the Ice age, or to account for the disappearance of that age." Mr. Manson's theory is that the direct cause of the glaciation was the exclusion of solar heat from those regions where the ice development was taking place, and that the disappearance of the ice northward and southward was caused by the natural earth heat breaking through the ice crust, after which, assisted by the solar agencies, it began to gather heat and dispersed the cold toward the arctic and antarctic regions relatively as the land area predominated. The book is for sale by William Doxey, 631 Market Street, San Francisco. Price, 75 cents.

Volume X of the *United States Fish Commission Bulletin* is an important contribution to the scientific and industrial literature of the fishes and fisheries of the country. Besides articles on The Oyster and Oyster-culture, by Bashford Dean, which have already been noticed in these pages, it contains a valuable paper on the Fishing Vessels and Boats of the Pacific Coast, by Captain J. W. Collins; a report on the fisheries of the New England States; and various articles and reports on the aquaria of the United States Fish Commission and the conditions of the fisheries of Kentucky, Iowa, Lake Ontario, etc.

In the article on the Fishing Craft of the Pacific Coast, besides a fund of useful information and suggestion, Captain Collins describes the appearance, construction, and sea-going qualities, as well as their general adaptability to the several fisheries, of all kinds of boats and vessels, from the Alaskan *kaiak* (canoe) to the perfectly appointed whaler, and illustrates the text by thirteen plates and four figures. The fisheries of the New England States are also exhaustively treated, the report chiefly consisting of statistical tables of their condition, with an analysis of the quantities of the various fishes captured, the number of men and boats engaged, and the amount of capital invested.

In the report of the fisheries of Lake Ontario, Hugh M. Smith, M. D., gives an interesting account of his investigations, which were made with a view to the establishment of a fish-hatching station on the lake. The volume is fully illustrated with ninety-four full-page plates and ten figures in the text. Pp. 436. Washington, 1892.

A Concise History of Religion has been prepared by *F. J. Gould* for the issues of the Rationalist Press Committee of London. In the first volume, the only one that yet appeared, are given brief accounts of the principal religions of the world except Judaism, Christianity, and Mohammedanism, preceded by an analysis exhibiting the chief phases of primitive worship, and the main lines of religious development. The list of religions treated include about fifty. The author proposes to follow this volume with other parts dealing with the Bible, Judaism, Christianity (from the point of view of a purely human origin), and modern Rationalism. (London: Watts & Co.)

The book *Hermetic Philosophy*, vol. iii, "A comedy founded on Plato's Meno, applied to modern discoveries in theosophy, Christian science, magic, etc., and to those who are seeking these discoveries," bearing the signature of Styx, and published by the J. B. Lippincott Co., Philadelphia, discusses the question, "Can virtue and science be taught?" There is a vein of levity running through the whole, yet the author's purpose appears to be serious. He has taken Plato for his pattern and applied his mode of illustration to modern mental phenomena—to the discussion of "the merits of a few self-appointed leaders among the thousands of those who feel that there is a call in the mind for them to begin on the 'mighty work.'" Among these pretenders are named "Adepts, Hon. Magi, Mahatmas, Children of the Sun, the Divinely anointed," and Christian scientists. The author's point of view is indicated by the question, "Is not the man who presents himself for common spectacle as one pos-

sessing gifts direct from the hand of God, for which he is a specially selected and ordained recipient, either a fool, a fanatic, or a rascal?"

The *Religious Herald* (Hartford, Conn.) presents to its subscribers as a souvenir of fifty years' publication of the paper, a large and profusely illustrated volume entitled *Picturesque Chicago and Guide to the World's Fair*. It consists of descriptions of the city, its parks, benevolences, business houses, institutions, and other peculiar features, illustrated by more than fifty photographic reproductions. The mechanical execution is of the most pleasing character.

A view of what some socialistic agitators might do if they had opportunity is given in a little book entitled *Is it Right to rob Robbers?* by *Morrison L. Swift*, published by the Commonwealth Society, Boston. The "robbers" of the story are capitalist employers. A plot formed by a few clerks to steal regularly from the moneys of their concerns and distribute the sums among the needy, spreads till it includes nearly all the employed and vast corporative concerns have been built up out of the proceeds, "labor" has found its level as high as capital, and all of society—manufacturers, the legal profession, education, and what not—are affected by the conditions developed. Detection comes at last; capital shows its cruel hand in the prosecution of the thieves, now numbering many thousands; convulsions and almost revolution follow, till at last insolent capital is forced to yield and share in the universal partnership.

No. 10 of the third volume of *Werner's Readings and Recitations*, compiled and arranged by *Caroline B. Le Row*, (quarterly, Edgar S. Werner, 28 West Twenty-third Street, New York), is known as America's Recitation Book, and includes pieces, by American authors only, on great events in the history of our country, arranged according to the chronology. The pieces are classified as relating to Discoveries, Settlements, French and Indian Wars, Revolutionary War and Declaration of Independence, the War of 1812 and the Mexican War, and the Civil War and Emancipation Proclamation.

The *Conversations on some of the Old Poets* were published by Mr. *J. R. Lowell* in 1845, and again in a revised edition in 1846; and were reprinted in London in 1845. They were afterward allowed to pass out of print. Mr. Lowell did not include them in his collected works, regarding them as in a measure superseded by his later and more mature writings on like subjects. They have, however, a value and interest that have not been lessened by time or by the author's growth in fame; and although a self-restraint with which we can find no fault may have prevented the author from pressing his thoughts on the same subjects twice upon the public, often greatly modified the second time and perhaps contradictory of the first impression, such scruple need not now exist to exclude the reading public from what is really a very enjoyable and instructive series of essays. The conversational form was adopted partly because the essays were discursive, and partly to enable them to be so without violation of the canons of literary propriety. They have their faults, which appertain to the youthfulness of the author at the time he wrote them; but, as the present publishers well say, Mr. Lowell's reputation can better afford the faults than our literature can afford the suppression of the work. The present edition is published, with an introduction by Robert Ellis Thompson, by David McKay, Philadelphia.

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POPULAR MISCELLANY.

Notes from the Madison Meeting of the American Association.—At the Madison meeting of the American Association for the Advancement of Science, the pressing necessity for giving availability to the world's wealth in scientific literature was discussed. In the Botanical Section was suggested the desirability of a bibliography for botany such as that compiled for chemistry by Prof. H. Carrington Bolton. It was further proposed that the bibliographical volumes be supplemented by a serial index. In the Mechanical Section Mr. C. Wellman Parkes, of Troy, N. Y., outlined a weekly index to periodicals which he promises to establish in New York with the new year. During each quarter the numbers will successively recapitulate all the titles from the beginning of the quarter. At the end of the sixth, ninth, and twelfth months special numbers will recapitulate all the titles from the beginning of the year. The reclassifications needed for this index are to be rendered easy by adopting a machine casting each title as a solid line of type metal.

Prof. Bolton's bibliography of chemistry is published by the Smithsonian Institution. At the recent Congress of Librarians in Chicago it was stated that this institution may publish other similar bibliographies for which manuscripts may be prepared by learned societies. As a good many of these societies have moderate funds available for the purpose, and as societies still more numerous could arrange for gratuitous co-operation, on the plan of the American Library Association with its index to periodicals, the impulse to organization seems to be all that is lacking in order to supply a crying need of the times.

Prof. Edward Hart, of Easton, Pa., adverted to the importance of mechanical aids in analytical chemistry. Balances, he said, are now made with short arms, and are in consequence more rapid. They are provided with agate knife edges to resist corrosion, with aluminum beams for lightness, with better weights, with improved beam and pan arrests. The torsion balance, due to Dr. Alfred Springer, of Cincinnati, enables a heavier load to be weighed with greater sensitiveness. The Gibb ring-burner much improves the Bunsen lamp: it allows the upper part of a crucible to be heated so that liquids boiling at high temperatures may be evaporated without spattering.

Prof. T. M. Drown, of Lafayette College, first used, in 1875 or 1876, the crucible with perforated bottom which, reinvented in 1879 by Prof. F. A. Gooch, with the addition of asbestos felt, is invaluable in certain analyses. Filters of paper, when unsatisfactory, can be replaced by Gibbs's sand filter, Munroe's clay filter, and Carmichael's siphon filter. The chemist with recent years has added two metals to the list from which his vessels are drawn—nickel and aluminum. In the cheap and ready supply of reagents, which a few years ago were troublesome to make and costly of purchase, industry has done an important service to research; today hydrogen dioxid, bromin, and potassium permanganate are articles of commerce and bear moderate prices.

Prof. E. L. Nichols, of Cornell University, referring to the phenomena of alternating currents, said that their complexity had obliged the modern electrician to be both a mathematician and a physicist. In much the same way a generation ago the new and difficult phenomena of cable telegraphy served to train the men who stand as pioneers and chieftains in electrical science.

Prof. W. H. Brewer, of New Haven, Conn., speaking of stock-breeding, said that as long ago as 1812 a thousand guineas had been paid in England for a short-horn bull. The Short-horn Herd-book, published in 1832, and the Stud-book, yet earlier, had laid the foundation for the science of heredity in part by proving that cross-breeding induced variability. Within the modern era the only additions to domesticated animals have been the canary and the ostrich.

As showing how far mechanical and chemical economy has saved labor on the farm, Prof. Brewer cited Johnson, who estimated fifty years ago that ninety per cent of the capital of the United States was invested in farming; to-day the proportion has fallen to one third.

Anthropological Material.—In his anniversary address as President of the Anthropological Institute of Great Britain and Ireland, Prof. E. B. Tylor remarked on the fear felt by some that one of the main topics of anthropology would before long dwindle or disappear. When the savages and barbarians are disposed of by civilization or extirpation, their anthropological material is more or less exhausted. At present, however, this is so far from having happened that the supply is on the whole better and more plentiful than ever. With many tribes, indeed, the record is closed, as with the Tasmanians, those representatives of the palæolithic age in modern times, who can give us few more details of the lowest known stage of culture beyond those collected by Mr. Ling Roth. Not to give a whole list of modern works, it is enough to say that for minutely accurate accounts of uncultured life, none excel Codrington's Melanesians and Kubari's treatise on the Pelew Islanders, and we can only regret that the anthropologists of past centuries were not alive to the need of such minutely careful study of the tribes who were then, but are not now, in a state to be thus studied. One class of anthropological material, of which the quantity available has only lately been appreciated, is folk lore. When, fourteen years ago, the speaker took part in founding the Folk-lore Society, for the preservation and publication of popular traditions, legendary ballads, local proverbial sayings, superstitions, and old customs, and all subjects relating to them, he as little as others anticipated how many volumes of such matter it would produce, or of how great value they would be, as to the main purpose of tracing the development and diffusion of popular tradition and fancy, and as to the incidental knowledge of man which is preserved in them. Especially to students of the development of ethical ideas, folk-lore studies are exceptionally valuable, recording as they do in their incidents what were the ideas on good and bad actions, not indeed of the age in which the stories are gathered, but of a remote past kept thus in memory. Speaking of the reports of investigations among the Indians of Northwest America, Prof. Tylor said it was a ground of satisfaction, in looking through them, to feel that a systematic account of the anthropology of British Northwest America is to a great extent completed. "Not that everything requiring record has been recorded. Observation of rapidly changing native life will still tax to the extreme the efforts of the anthropologists of the Canadian Dominion, but it is a great work to have the framework already set up to be filled in future years."

Officers of the American Association.—The next meeting of the American Association for the Advancement of Science is to be held August 16 to 22, 1894, probably in Brooklyn, N. Y., under the presidency of Daniel G. Brinton, of Media, Pa. The following are the vice-presidents and secretaries of sections and general officers elect: *Vice-Presidents:* (A) Mathematics and Astronomy—George C. Comstock, Madison, Wis.; (B) Physics—William A. Rogers, Waterville, Me.; (C) Chemistry—Thomas H. Norton, Cincinnati, Ohio; (D) Mechanical Science and Engineering—Mansfield Merriman, South Bethlehem, Pa.; (E) Geology and Geography—Samuel Calvin, Iowa City, Iowa; (F) Zoölogy—Samuel H. Scudder, Cambridge, Mass.; (G) Botany—Lucien M. Underwood, Greencastle, Ind.; (H) Anthropology—Franz Boas, Worcester, Mass.; (I) Economic Science and Statistics—Henry Farquhar, Washington, D. C. *Permanent Secretary:* F. W. Putnam, Cambridge (office, Salem), Mass. *General Secretary:* H. L. Fairchild, Rochester, N. Y. *Secretary of the Council:* James Lewis Howe, Louisville, Ky. *Secretaries of the Sections:* (A) Mathematics and Astronomy—Wooster W. Beman, Ann Arbor, Mich.; (B) Physics—Benjamin W. Snow, Madison, Wis.; (C) Chemistry—S. M. Babcock, Madison, Wis.; (D) Mechanical Science and Engineering—John H. Kinealy, St. Louis, Mo.; (E) Geology and Geography—William Morris Davis, Cambridge, Mass.; (F) Zoölogy—William Libbey, Jr., Princeton, N. J.; (G) Botany—Charles R. Barnes, Madison, Wis.; (H) Anthropology—Alexan-

der F. Chamberlain, Worcester, Mass.; (I) Economic Science and Statistics — Manly Miles, Lansing, Mich. *Treasurer:* William Lilly, Mauch Chunk, Pa.

A Correction.—Owing to some defect, the cut on page 459 of the August number of the Monthly, intended to illustrate a peculiar form of lightning flash, fails to show the characteristic features of the phenomenon as brought out in the photograph. We present herewith another cut which is an excellent reproduction of the photograph, and with it an explanation of the peculiar appearances observed in the picture.

Impulsive Rush Discharge, So-called Dark Flashes.

The illustration herewith is to be substituted for the illustration with the same legend on page 459 of The Popular Science Monthly for August. The flash was photographed by the writer at Blue Hill Observatory, and was one of the most intense flashes he has ever seen. To the eye it appeared as a straight core of dazzling light, with a jacket of luminous air in diameter six or seven times that of the core. The name "impulsive rush" is from Dr. Oliver Lodge's classification of lightning discharges. The so-called "dark flashes" can be distinctly seen branching out from the core. Briefly, these may be the result of previous exposure, and the flashes altogether distinct in time and place; or, a reversal of a flash brought about by the glare from subsequent illuminations; or, a reflection from the lens (although a plain view lens was used), or an absorption effect connected with chemical change in the gases of the atmosphere. It is needless to add that the negative was carefully kept from alteration or retouching of any kind.

Alexander McAdie.

Reasons for Emigration.—The conclusion of an inquiry made under the direction of our Commissioners of Immigration upon the causes that incite immigration to the United States is that, except in Russia, where emigration is abnormal, the primary causes are the superior conditions of living in the United States, the fewer hours of labor, the exemption from the exactions imposed by foreign governments upon their citizens, and the general belief that the United States presents better opportunities for rising to a higher level than are offered at home. Information on these points is usually furnished by friends or relatives who have preceded the intending emigrants and have established themselves here. It is estimated that nearly sixty per cent of the immigrants who land in our country come on prepaid tickets or money sent by friends

already here, and that they in turn influence a considerable percentage of immigration that comes on tickets purchased directly in the Old World. The prepaid business is largely affected and increased by even temporary improvement in our conditions here. So far as this class of immigrants is concerned, it argues against the belief that exists in the minds of many of our people that the quality of immigration, as to character, is inferior to that of former years, as it necessarily follows that the class who are prepaid, belonging to the same families as those who prepay, must be of the same general character. This information as to our conditions is also supplemented by the large number of persons who return to their native lands temporarily, and whose improved appearance, enhanced prosperity, and statements to their old friends disseminate the knowledge of the better conditions in this country. A reference to the table of steerage passengers returning to all parts of Europe during the year previous to the making of the report demonstrates the volume of this business. Low passage rates, sea and inland, affect the currents both coming and going. Generally, wherever the manufacturing industries are active emigration is sluggish; and it is small wherever the wages are fairly good as compared with the standard of wants and manner of living of the working people. In addition to the superior conditions prevailing here, the conditions in Europe greatly affect the outflow. Short crops, industrial depression, social persecutions, and rumors and anticipations of war swell the tide.

Prof. N. T. Lupton.—Nathaniel Thomas Lupton, Professor of Chemistry in the Alabama Agricultural and Mechanical College, a pioneer in America in teaching chemistry as a practical science, died in Auburn, Ala., June 11th. He was a native of Virginia; studied chemistry under Bunsen at Heidelberg, worked with him afterward, and made special investigations in his laboratory after his own fame had been established in America. He was engaged during a large portion of his life in original research, at home, in Mexico, and in Europe; was connected with several Southern institutions of learning, including ten years at Vanderbilt University, and built up the school of chemistry at Auburn, Ala. He was much interested in other sciences than chemistry, particularly with ethnology, and contributed largely from his Mexican, Western, and Southwestern researches to the Smithsonian collection of relics of the Indians and mound-builders. His own collection of minerals and prehistoric relics is extensive and interesting. He was twice President of the Chemical Section of the American Association, was President last year of the Association of Official Chemists of the United States, and was a member of several foreign scientific and other societies. He was the author of a book on scientific agriculture, and a frequent and valued contributor to the scientific publications of this country and Europe.

Copper Works of the Aborigines.—The present evidence regarding the use of copper by the aborigines of this country, as reviewed by R. L. Packard, in the American Antiquarian, appears to show that the metal had not passed its ornamental or precious stage on the seaboard or in the South at the time this continent was brought to the attention of Europe. It was not part of the native equipment, either for war, or hunting, or other useful purposes, and its position in the native economy was not like the noticeable part it played in the armament of the Mexicans and Central Americans of the same period. In the absence of evidence that the Indians of the United States had any knowledge of smelting, it must be inferred that all the copper they possessed was found in the metallic or native state. There is nothing to show that they were aware of the existence of copper ore as a source of metal. No remains of smelting places, or slag, or other indications of metallurgical operations have yet been found. The quantity of copper which the North American Indians possessed at the time of the discovery, although the metal was diffused over a very wide territory, was very small as compared with stone. This is shown by the relatively small proportion of copper implements in the principal collections, as at the Smithsonian Institution and the Peabody Museum. The larger numbers are found in Wisconsin, and this is accounted for by the fact that Wisconsin is directly south of the Keweenaw district in Michigan where the largest beds of native

copper occur. In these beds the copper is classed as stamp rock, in which the metal is contained in fine particles and is separated by crushing; "barrel work," or the pieces of copper that are large enough to be detached from the rock without stamping, which are shipped in barrels; and mass copper, or the very large pieces. All this copper shows as such in the rock, and the ancient miners had only to follow down a promising outcrop showing "barrel work" for a few feet, and hammer away the rock from the copper to secure the latter. When they came upon mass copper they were compelled to abandon it after hammering off projecting pieces, because they had no tools for cutting it up and removing it. Several instances of this sort have been found. The ancient mines were not mines in the strict sense of the word, because they were not underground workings, but merely shallow pits or trenches, and sometimes excavations in the face of the cliffs. At the time modern mining began they had become mere depressions in the ground. All these workings when examined contained countless stone hammers or mauls, a few wooden shovels, remains of wooden bowls for baking, birch-bark baskets, and some spear or lance heads, and other articles of copper. Opinions and evidence vary as to the age of the operations. Modern miners would regard the whole system as nothing more than prospecting work, and not mining proper, as there were no shafts or tunnels or underground workings.

Feeding Value of Tree Leaves.—Experiments on the feeding value of the leaves of trees, made by M. C. H. Girard, point to them as an available source of nutriment for cattle, particularly in times when hay and grain are scarce. The author has determined the content of nitrogenous matters in a considerable number of species. It ranges from eight per cent in the willow and alder to from three to four per cent in the plane, birch, and pine. Out of twenty-one kinds of leaves studied, nineteen possessed more nitrogenous matter than meadow hay, and more than half of them were superior to the hay of the best leguminous plants. Some are of extraordinary richness, the common acacia, for example. M. Girard was able, from his analyses and from direct experience in feeding sheep, to draw the conclusion that the leaves have a feeding value comparable to that of lucern. They are also superior in the proportion of fat matters and other carbohydrate principles to that of water. Leaves taken from various heights of the trees and from trees of various ages show but little variation in composition; and, putting aside the periods of youth and of extreme old age, the richness of the leaf in nutritive value remains almost stationary. Consequently, crops can be gathered during the three summer months; and in September the wood production of the trees would not be prejudiced.

Gilbert White's Character.—The Selborne Society, of London, celebrated the centenary of the death of Gilbert White, June 24th, by making a pilgrimage to Selborne, where the earl of that ilk spoke to the memory of White. He said that the impression which most people had formed of White from his book was that he was a man of excellent natural abilities, strongly cultivated, and of wide classical attainments and accomplishments. He was not only an observer of Nature, but one who prepared himself for observation by the best mental cultivation. No one could read his book without seeing his remarkable faculty of observation, and the constant aim at exactness and accuracy, together with a good deal of humor. Nor could any one help being struck with the modesty and simplicity of his character. His simplicity, which contributed a very great charm to the book, every now and then produced even a sense of amusement. The speaker was visited, in 1872, by Mr. W. M. Evarts, who, like most other cultivated Americans, was acquainted with White's book, and had a great regard for his memory. One day, when driving, the Sussex downs were pointed out to Mr. Evarts, who burst into laughter, remembering a passage in which White referred to the downs as "a vast range of mountains." His shrewdness of discernment was a most valuable gift, and he loved all God's creatures, but perhaps especially birds. By this he reminded one of two great men. The one, mythical, was Melacampus, who rescued and brought up some young serpents. One day, when he slept, the serpents nestled round his head, and when he woke he found he could under-

stand the language of birds. The other was Francis of Assisi, who was in some measure the forerunner of Gilbert White. There was a legend that he so loved the birds that they flocked around him while he preached sermons to them. The legend at least showed his love for those creatures and his power of making them love him. These characteristics of Gilbert White could be gathered from his book; but the picture was filled up by the mass of family correspondence which had just come to light. The combination of simplicity and refinement, the absence of ostentation and self-consciousness which constituted the great charm of White's book were equally conspicuous in his family correspondence and in his every-day habits. The Earl of Stamford, who has been collecting reminiscences and unexplored documents connected with his great relative, White, said that years ago an old woman was asked what she remembered of him. She said that he used to walk about the lanes tap-tapping with his cane, and stopping every now and then to brush the dust off his shoes.

Unexplored Mountain Regions.—While many of the mountain districts of the world, hitherto unexplored, have been reached in recent years by scientific mountaineers, yet, excepting Switzerland and the Pyrenees, which have been entirely explored by the different Alpine Clubs, there is no chain of mountains, as Mr. Edwin Swift Balch shows in his essay on Mountain Exploration, which is as yet thoroughly known or perfectly mapped out. New Zealand, though settled and inhabited by Englishmen for many years, had to wait till a few years ago for Mr. Green first to explore its Alps. The Himalayas, although the Indian Government has tried to map and explore them, are still in many cases keeping their secrets until men shall come along who know the science of climbing. Mr. Graham's trip in the Sikkim ranges in 1886 showed conclusively how little was known about the Himalayas, as he has now left us in doubt as to whether the two peaks which he saw from the top of Kabru were not higher than Gaurisankar. In America there is a large field left for mountain exploration. Of the Selkirks we know but little; St. Elias has not been reached; the Alaskan ranges and Mount Fairweather and Mount Cook are believed to be entirely untouched. The Mount Wrangel range is hardly known, even by name, and though it is said to have been measured and to be over twenty thousand feet high, we know practically nothing about it or its surroundings. On the map of the northern Rockies, north of the Selkirks, we find a bunch of peaks, called Mount Brown and Mount Murchison, and marked as being over sixteen thousand feet high. Of these mountains we again are in almost complete ignorance, though from Mr. Green's explorations we may doubt the accuracy of their supposed altitude. In South America the Andes of Peru and Chili are mostly still unascended, and even Ecuador has had only one serious exploration, by Mr. Whymper. Here is unexplored mountain country enough to occupy our clubs several years.

Vegetation of American Deserts.—The true sagebrush of the Western desert (*Artemisia tridentata*), according to Prof. C. Hart Merriam, begins with a solid front along the southern border of the upper Sonoran zone and spreads northward over the Great Basin like a monstrous sheet, covering almost without a break hundreds of thousands of square miles. It is not only the most striking and widely diffused plant of the upper Sonora and transition zones, but as a social plant has few equals, often occupying immense areas to the exclusion of all but the humblest and least conspicuous forms. Wherever one travels in this vast region, the aromatic odor of the sagebrush is always present, and sometimes, particularly after rains, is so powerful as to cause pain in the nostrils. In addition to the sage, many of the desert ranges support a growth of shrubs and small trees rarely if ever found in the intervening deserts and plains, whatever the altitude. The so-called cedar (*Juniperus californica utahensis*) and the piñon or nut pine (*Pinus monophylla*) clothe the summits and higher slopes of many of the ranges, forming stunted open forests of much beauty. Mixed with these are scattered clumps of bushes representing a number of genera, most of which bear green foliage and handsome flowers. Some of the desert ranges, as the Funeral Mountains, are too excessively hot and arid to support even these forms of vegetation;

others, as the Charleston Mountains, push their lofty summits into so cold an atmosphere that they obtain a covering of the boreal pines and firs. These higher mountains, when rising from the lower Sonoran deserts, present in succession all the extratropical zones of North America, which, from their close juxtaposition, may be here studied to unusual advantage. In ascending or descending such slopes the change from one zone to another is quickly recognized, and the altitude of first appearance of the various new species encountered may be recorded with considerable confidence. Not so, however with the species lost, for, except in the case of trees and such strikingly conspicuous forms as the yuccas, some of the cactuses, the creosote bush (*Larrea*), and a few others, it is exceedingly difficult to detect the disappearance of species when passing out of their ranges.

The Rattlesnake's Rattle.—The idea that the rattles of a rattlesnake correspond with its years is, according to Dr. Arthur Stradling, incorrect. "When the little *Crotalus* is born," this author says, "its tail is furnished with a single tip of horn, incapable of producing any sound by the violent vibration which its owner nevertheless communicates to it when excited. In some near relations of the rattlesnake, such as the *çurucucu* of Brazil, this horny claw or nail persists throughout life without addition thereto. But in the rattlesnakes proper—and there are many species of them—two, and sometimes three, joints appear during the first few months of the creature's life; then and later there is probably no definite relation between their number or frequency of development and its age, though they may be proportionate in some measure to its rate of growth. Broods of young serpents belonging to this genus which I have reared have exhibited great diversity in this matter; so much so, that it has been impossible to base any calculation on observations of the phenomena presented by them. The overlapping 'thimbles' or cones of which the rattle is composed are thin, dry, and exceedingly brittle, and in consequence the instrument is easily broken off when it has reached the length of from one to two inches, though longer specimens are occasionally seen; twenty joints make an exceptionally big rattle. This shedding of the rattle is in all cases accidental, and is due to external causes, not a constitutional and periodical function like the casting of the skin. When it breaks off at the root or in the middle, there is generally no trace left of a fracture having taken place, as the thimbles are all alike, and any one forms a symmetrical termination to the organ. Whatever purpose the rattle may serve in the snake's economy—and its use is still involved in some obscurity—it undoubtedly does *not* represent the owner's age, nor the sum total of his manslaughter."

Energy in Organic Evolution.—In two papers, Mr. John A. Ryder has endeavored to demonstrate the potency of energy as a factor in organic evolution, and to show that the form of the hen's egg is determined by mechanical means while the egg membranes and shell are in process of formation within the oviduct. The development of the figure of eggs is regarded by him as a purely dynamical problem, or one in which energy is applied in a definite manner to a mass in statical equilibrium within the oviduct. The moment motion is set up to propel the egg through the duct the forces operative in determining the figure of the as yet unformed shell depend upon the physiological activity and condition of tone of the muscular walls of the oviduct.

Cremation of Cholera-dead.—From a paper read by Dr. Robert Newman before the Northwestern Medical and Surgical Society of New York in favor of the cremation of persons dying of cholera, it appears that there are now fifteen crematories in this country, and that two thousand and seventeen incinerations took place between 1887 and 1892, of which eight hundred and sixty-eight were at New York. The Earl Memorial Crematory, at Troy, is the most costly. Thirty-two active cremation societies are scattered over the country. Nearly all those who participated in the discussion of the paper agreed with the author as to the importance of cremation in cholera. In respect to the objection—the only really important and valid one that has been made—that cremation facilitates the concealment of crimi-

nal poisoning, the observation of an eminent but unnamed chemist was quoted, that alkaloidal poisons are destroyed by burial as well as by cremation, so that the only poison that would not be discovered after cremation and which might be detected after ordinary burial is arsenic.

Endurance in Animals.—The tradition, says an English writer, which assigns to certain animals a daring and endurance difficult to match in man, is so old, and on the whole so consistent, that it would be impossible to disregard it, even were the facts on which it is based less clearly within the limits of ordinary observation and comprehension than they are. It may even be doubted whether our measurement of animal courage has yet been sufficiently extended, for there appear instances in which the acts of daring are prompted by a sense of obedience, of discipline, and even of duty—something similar in kind to that which marks and distinguishes the highest forms of courage in man.

NOTES.

An English edition of the Reminiscences of Werner von Siemens, to which we are indebted for the material of the sketch of him published in this number, is now in press and shortly to be published by D. Appleton & Co. It abounds in stirring incidents and bright anecdotes.

A World's Congress of Evolutionists has been called to meet in the Art Building, Chicago, September 27th, 28th, and 29th. Morning, afternoon, and evening sessions will be held each day. A carefully arranged programme of subjects has been provided for the discussions. The first subject, set down for the morning session of September 27th, is Constructive Evolution. Progress of the Doctrine in Forty Years. Its Present Scientific and Popular Status. Its Upbuilding and Beneficent Character. Other subjects, under each of which are several subheadings, furnishing a wide and varied scope for expression by different speakers from their respective points of view, are Biology as related to Evolution; The Heroes of Evolution (Darwin, Spencer, Wallace, Haeckel, Gray, Youmans, etc.); Psychology as related to Evolution; Sociology, with Evolution's Promise for the Settlement of Social Problems and the True Conservatism of Evolution; Economics as related to Evolution; Philosophy as affected by Evolution; Ethics, the Moral of Evolution; and the final series, Religion: how it is affected by the Doctrine of Evolution, Spiritual Implications in all Progress, Materialistic Speculations Untenable, The Immanent and Transcendent Power that makes for Beauty, Order, and Righteousness. The arrangements for the congress are under the guidance of Dr. Lewis G. Janes, James A. Skilton, and other persons of representative character. All friends of evolution are invited to attend.

A writer in the London Spectator suggests that, in studying the intelligence of animals instead of ourselves, we should compare them with men who are more or less in the same state of education with them. He lives in Bolivia, in a country close to three tribes of Indians who are more or less savages, although engaged in agriculture of a desultory kind; and he has had it forced upon him on various occasions that the nobler animals—such as the horse and the dog—are quite as capable of "reasoning" or "thinking" out the ordinary problems of maintaining their existence as those savages. "Of the wild animals, many put whatever brain power they possess to 'cunning.' Again, what is 'cunning'? Their cunning is very similar to that of the Indians of this country, who would rank high among savage races."

According to an observation by C. Margat, of the University of Geneva, when aluminum, previously well cleaned, is lightly rubbed with an amalgam, its surface becomes covered with an arborescence of alumina, which can literally be seen to grow, and in the course of half an hour the forest may reach the height of a centimetre. The growth ceases on the application of heat, to be resumed on a new rubbing with the amalgam. If the forest growth is brushed away, the surface of the metal where the oxidation was most rapid will be found to have been eaten, as if with an acid. The mercury acts in some way to make the aluminum more amenable to oxidation. The experiment is more conveniently performed with an amalgam than with pure mercury, because the amalgam can be powdered and brought into more immediate contact with the aluminum.

In the investigation of the purity of the ice supplied to Paris, Lac Daumesnil at Vincennes, whence a considerable proportion of the natural ice comes, has been found to be polluted by the entrance of a sewer and by an artificial stream from the plateau of Gravelle. It is proposed to limit the use of this ice to applications in which it is not brought into direct contact with the articles to be cooled, and to enforce the use of artificial ice got exclusively from spring water or from river water sterilized by heat, when such contact takes place.

Lake Memphremagog, on the line between Vermont and Canada, has been sub-

jected to a hydrographic examination by Mr. A. T. Drummond. It is a deep-water lake, giving soundings of six hundred feet, and is found by Mr. Drummond to be also a cold-water lake, giving bottom temperatures in August of 44·75° Fahr., with the high surface temperature maintained for relatively only a few feet; beneath this depth the mercury falls rapidly toward the lowest reading.

A WRITER in the Lancet calls attention to our still persisting lack of practical knowledge on the hygiene of schools, although a complete revolution has taken place during the past fifty years in our ideas relating to the management of children and the methods to be adopted in educating the young. This position of affairs seems to have arisen, not from any want of knowledge in sanitary affairs, but rather from lack of system in following up the subject. We habitually insist that certain conditions shall be fulfilled before a dwelling house shall be considered habitable or a hospital fit for the reception of patients, and in other matters, but do not as firmly stipulate that certain rules shall be followed in the building of schoolhouses.

A NUMBER of the plates—so many of them being missing as to preclude the formation of couplete sets—of Audubon's Birds of America, are offered for sale by Estes and Lauriat, Boston, at largely reduced prices. Of many of the plates but few copies are in store, and, the original stones having been destroyed, it is certain that no more copies will be published.

VOLUME V, No. 2, of Insect Life is chiefly filled with proceedings of the sixth meeting of the Association of Economic Entomologists, which was held in connection with the meeting of the American Association at Rochester in August, 1892.

METALLURGY is tending to become one of the most efficient producers of manures in the world. Twenty years ago, says the *Annales industrielles*, twenty thousands tons of phosphoric acid were as poison to the two million tons of cast iron which England produced, while English ships were ransacking the most distant regions of the globe for phosphoric acid for agriculture. The basic process has been the end of this anomaly. Apparatus attached to the furnaces in Scotland for the recovery of the ammonia out of the furnace gases have furnished a new and important source of sulphate of ammonia for agriculture.

A CURIOUS method of anthropometrical measurement for the determination of identity is described by the French Captain Cupet as in use in southern Anam. A sliver of bamboo is placed between the middle and fore fingers of the left hand of the person it is desired to identify, and on it notches are cut to mark the base of the nail and the distance between the phalanges. The stick is kept, to be used as occasion requires when the identity of the person in question is to be established.

THE emerald mines of Muzo, Colombia, are situated on the Minero River, about eighty miles northwest of Bogotá, and are farmed out to a French syndicate. They are situated in a very rough, wild country, with nearly impassable roads, and are worked by open cuts, with provision for washing away the *débris*. The rough stones are for the most part sent to Paris to be cut. About three hundred natives are employed at the works, and the yield is about one hundred thousand dollars a year.

THE advance in the knowledge of the coal fields of India, promoted by the Geological Survey of the country, is great. The centers of production, which a few years ago were almost confined to Bengal, have been extended to Assam, the Punjaub, the central provinces, the Nizam's territory, and Burmah. The survey has also done much to determine the character of the oil resources of the country. The Government is anxious to associate natives educated in the country with the European officers in the work of original investigation and research; but the attempt has had to be abandoned for the present in consequence of the difficulty of finding young men suitably educated for such a career.

OBITUARY NOTES.

THE Rev. Charles Pritchard, D. D., Savilian Professor of Astronomy in the University of Oxford, whose death was recently announced, was in his earlier life a teacher in the English upper middle-class schools, in which he distinguished himself by his efforts to exhibit an improved method of education. After thirty years of this occupation, he retired to become an active clergyman, but in 1870 was offered and accepted the professorship at Oxford. Here he secured the establishment of the university observatory; applied photography, before the gelatin plate came into use, to the moon and other bright objects; devised and used a method of investigating the magnitude of the brighter stars through a process of extinction by means of a wedge of neutralized glass; visited Egypt to determine the amount of atmospheric absorption; studied the mutual proper motions of the stars of the Pleiades; and began the investigation of the parallax of stars of the second magnitude.

THE death, on August 16th, is announced of M. Jean Martin Charcot, of the Salpêtrière, Paris, the eminent specialist in diseases of the nervous system. He was most distinguished for his researches in the field of insanity, hysteria, hypnotism, and of all those nervous phenomena which have been associated by many with magnetic influences.

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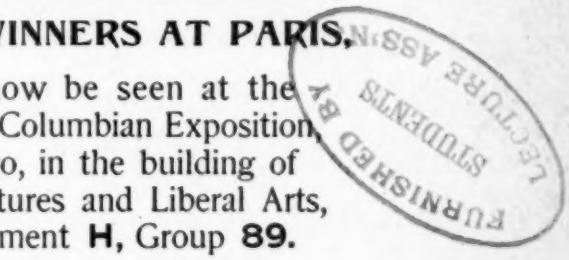

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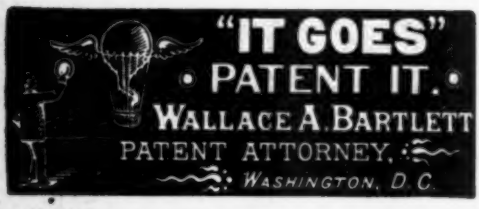

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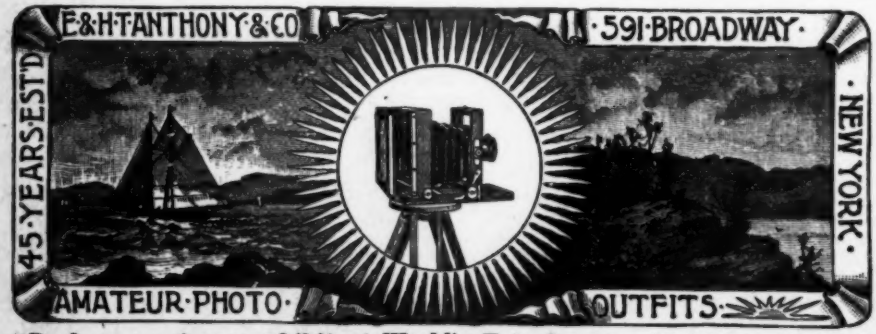

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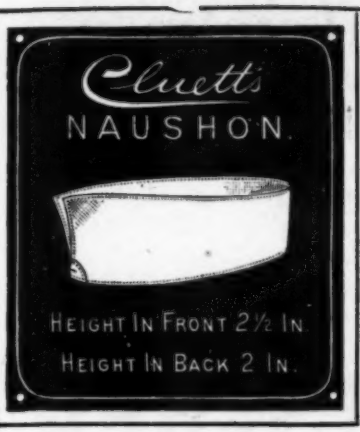

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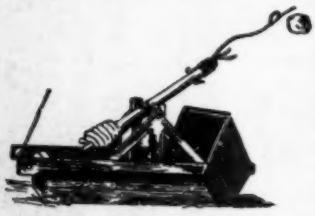

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OCTOBER, 1893.

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ASSETS.

Real Estate	$12,531,016 75	
Stocks and Bonds	86,680,177 51	
Bonds and Mortgages	24,236,765 51	
Loans secured by collaterals	3,916,000 00	
Premium Loans	1,096,850 03	
Cash in Office and in Banks and Trust Companies	4,201,283 68	
Interest and Rents due and accrued	971,810 14	
Net Amount of uncollected and deferred Premiums	3,865,275 37	
TOTAL ASSETS		**$137,499,198 99**

LIABILITIES.

Reserve, or Value of outstanding Policies	$119,075,888 00	
Other Liabilities	1,618,362 89	
Total Liabilities		**$120,694,250 89**
Surplus, being the same amount which will be shown to be the Company's Surplus by the Annual Report of the New York State Insurance Department as of December 31, 1892		**$16,804,948 10**

INCOME.

Total Premium Income	$25,040,113 93	
Interest, Rents, etc.	5,896,476 90	
Total Income		**$30,936,590 83**

DISBURSEMENTS.

Losses paid	$7,896,589 29	
Endowments paid	1,114,301 99	
Annuities, Dividends, Surrender Values, etc.	4,984,121 05	
Total paid Policy-holders	$13,995,012 33	
Commissions	4,178,316 80	
Agency Expenses, Physicians' Fees, Advertising and Printing	1,851,248 18	
Taxes, Salaries, and other Expenses	1,629,775 65	
Total Disbursements		**$21,654,290 76**

Number of Policies issued during 1892, 66,259. New Insurance, $173,603,070.

Total number of Policies in force January 1, 1893, 224,008. Amount at Risk, $659,248,829.

NOTE AS TO STATEMENT.—The above Statement corresponds in all respects with the Official Report of the Company as it will be published by the State Insurance Department. No Assets, not acceptable under the law of the State, or the Regulations of the Department, are included, and the SURPLUS ($16,804,948 10) IS THE EXACT SUM THAT WILL BE SHOWN BY THE SUPERINTENDENT'S ANNUAL REPORT.

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